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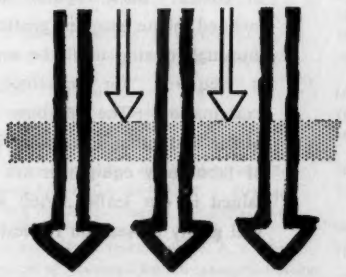

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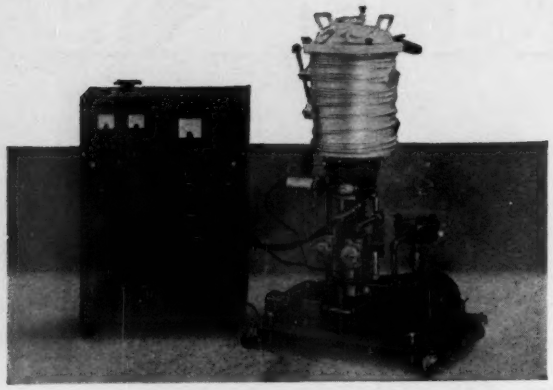

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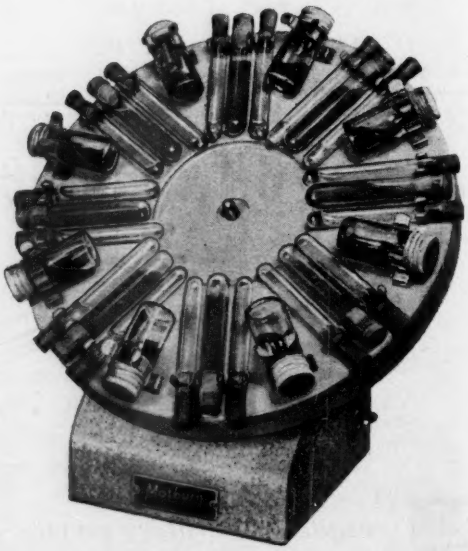

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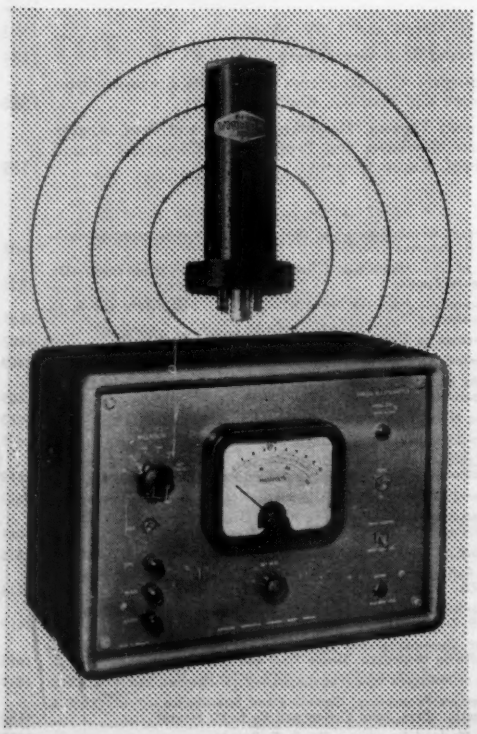

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TECHNICAL AND ECONOMIC ASSISTANCE

A PASSAGE in Mr. G. F. Kennan's Reith Lectures which has attracted comparatively little attention is that in which he criticized some common approaches to questions of technical or economic assistance to the under-developed countries. He challenged the thesis that there is any direct relation between economic assistance and political attitudes, and in particular that rapid economic development is as urgent as it is represented to be. He also made the pertinent point that economic progress must be related to the growth of population characteristic of these areas, and he rejected the suggestion that the West is in any sense responsible for the under-development of parts of the world. With some reason he pointed out that the development of parts of the globe sooner than others is natural and in no sense a moral issue; and for once we find an American lecturer taking a realistic view of Colonial relations as a natural and inevitable response to the demands and stimuli of historical periods, involving the agreement and connivance of Colonial peoples, as well as of the Mother Country, and benefits that were in no way one-sided.

It is recognized by Mr. Kennan that there are from time to time soundly conceived schemes of economic development which promise in the long run to yield greater stability and new hope to the countries concerned and that such schemes should be supported; but he insists that even the schemes will be useful only if the psychological basis is sound. He insists that every care must be taken to ensure that foreign aid or technical assistance is rendered from strength, and not interpreted by the recipients as a sign of weakness. He does not, in fact, regard foreign aid in general as a promising device for combating, on a short-term basis, the psychological handicaps under which Western statesmanship now rests in Asia and Africa.

Mr. Kennan regards aid to the under-developed countries as a common task of all the highly industrialized countries, in which the U.S.S.R. has its own contribution to make, and in suggesting that the problems should be handled so as to elicit that contribution or show up Russian reluctance, he is perhaps not quite so far from the policy which President Eisenhower is advocating to Congress as might at first appear. He admits that his proposals involve risks, and they would have to be elaborated into policy before they could be adopted; but they do involve a keener sense of the dignity of the Western position in Asia and Africa, as well as of the tangible diplomatic assets which we possess. They represent an approach from courage and confidence and a readiness to put matters to the test.

Such ideas deserve full examination when considering the resolution adopted last December by the General Assembly of the United Nations to establish a Special United Nations Fund for Economic Development. This Fund is intended to provide systematic and sustained assistance in fields essential to the integrated technical, economic and social development of the less-developed countries, beyond that provided by the existing technical assistance and development activities of the United Nations and Specialized Agencies. In the same resolution, the Assembly decided to review the scope and activities of the Special Fund when the resources prospectively available are sufficient to enter the field of capital development.

The Minister of State for Foreign Affairs, Commander A. Noble, said in the House of Commons on January 27 that the resolution embodies the proposals of the United States delegation for a Special Projects Fund and keeps the door open for the establishment of a United Nations multilateral capital development fund when sufficient continuing resources are seen to be available. The new Fund, which should come into existence on January 1, 1959, is welcomed by the Government, but Commander Noble pointed out that Britain already provides some £75 million a year for this sort of assistance.

It may also be recalled that the question of technical assistance is considered in some detail in a White Paper last July on the United Kingdom's role in Commonwealth development, which specially emphasized the provision of technical aid; and shortly afterwards several papers at the British Association meeting at Dublin also directed attention to those problems. Thus Prof. P. M. S. Blackett in his presidential address examined the differences to-day between the economic and social conditions of the West and the East and advocated a long-term loan of £1,000 million a year to the under-developed countries in addition to probable commercial and government short-term loans; Dr. H. J. Bhabha delivered an evening discourse on the economics of nuclear power development in India and the Indian nuclear energy programme (see *Nature*, **180**, 1382; 1957); technical assistance was discussed before Section L (Education) by Mr. Alec Dickson, and some problems of the under-developed countries were reviewed before Section F (Economics) by Mr. A. D. Knox, while Sir Sydney Caine dealt with education for development in a public lecture already noted in *Nature*.

Mr. Dickson's paper, "Technical Assistance and Idealism: Misgivings and Mistakings"—like a subsequent article by Prof. A. K. Cairncross in a recent issue of *The Three Banks Review*—is somewhat critical of Prof. Blackett's proposal. He affirms the importance of technical assistance and believes that it should be given to the maximum of our ability; but his concern is that we should give assistance in such a way that those we help should in their turn help others. He calls for hard and imaginative thinking about the contribution that best lies in our power to give to-day, and suggests that this may not neces-

sarily be in cash but in personal service of the highest quality.

To Mr. Dickson, the significant feature of Prof. Blackett's appeal is that it should have been made when America was appraising her whole Foreign Aid Programme, and Mr. Dickson's realistic comment on certain incompatibilities of thought in the programmes for foreign aid should, like Mr. Kennan's lectures, help to stimulate the constructive thought that is required. It is well to be reminded that it is very difficult to ensure that large sums of money contributed internationally to finance development or investment will, in fact, be used for the purpose intended; that under-developed countries tend to have under-developed governments; and that the ideal of international assistance is incompatible with the policy of neutralism. Further, against the great advantages of channelling aid through the United Nations rather than unilaterally from one nation has to be set limitation on the power of appreciation.

The core of Mr. Dickson's paper lies in his development of the idea that there is an art in giving internationally; and, although even here he would not claim to make any intrinsically novel proposals, drawing both on the notion of imperial trusteeship at its best and on ideas of Lewis Mumford in "Faith for Living", he displays the opportunities for experiment and need for something firmer than a material basis in technical assistance or foreign aid. Prof. Cairncross challenges the materialistic outlook no less firmly. He believes, indeed, that Britain could afford the additional loan of £150 million which Prof. Blackett suggested, but he doubts whether the £1,000 million could usefully be organized for a decade. It is almost twice the external aid (including loans) currently received by under-developed nations and more than a quarter of the current rate of net capital formation. Even a figure of £500 million would probably be regarded by the International Bank for Reconstruction and Development as exceeding the credit-worthiness of the under-developed countries.

The difficulty faced by many under-developed countries, Prof. Cairncross believes, is lack of demand for capital, not inability to attract it. External aid may sometimes be of limited value and is unlikely to play the same part in all countries, nor need the sequence of events be the same, and the strategic importance in development of some factors may differ. It is doubtful whether the creation of supply facilities in countries that lack other essentials of development will enable them to initiate development. There is no more surplus man-power, for example, in some under-developed countries than in the industrial countries of Western Europe.

Prof. Cairncross's view that a comparatively modest expenditure on expert technical direction may offer returns far exceeding those on other forms of expenditure is not unlike Mr. Dickson's. The real obstacles are ignorance, custom and bad management of existing resources, and these are the conditions that personal service can often do most to break down. Prof. Cairncross suggests that our policy should be to help those countries that are obviously trying to help themselves, and that we should be ready to run big risks for big stakes, for example, with India. There is no likelihood, he thinks, that private investment will of itself produce rapid development in backward countries, and some means is required of supplying industrial finance from abroad without leaving control in foreign hands, for example, through investment banks. Finally, the West could help by taking on some research and development that would allow more rapid introduction of modern technique, such as nuclear power, by narrowing the spread in capital costs between large and small plants.

Dr. Bhabha's lecture gave a fascinating glimpse of the implications of nuclear power in this connexion, and it will be remembered that the White Paper laid considerable stress on co-operation in nuclear science in Commonwealth development; but Mr. Knox's paper is at least a reminder of the impossibility of generalizing on the under-developed countries, and that the problems of promoting their economic expansion are in no sense easy. Mr. Knox was concerned largely with the market problems of under-developed countries, and particularly the importance of subsistence production and the difficulties of industrial development; but it is not difficult to see in the context of his paper the validity of Sir Sydney Caine's thesis regarding education for development. Imaginative planning, hard thinking and firm decisions as to the use to be made of limited resources are needed everywhere, and perhaps one of the most important consequences—though by no means a certainty—of the personal service for which Mr. Dickson pleads might be some abatement of the danger of emotionalism to which Sir Sydney refers.

It must be recognized then that only within very narrow limits can the Western countries expect to influence the wise use of the material resources which they place at the disposal of the under-developed countries; nor can we count on material factors as such to ensure conditions in which expert knowledge or personal service can be given in a wide range of fields. Even the brief summary of the arrangements through which technical assistance can be given within the British Commonwealth—in the independent territories or in the Colonial territories—indicates the immense advantage which the Commonwealth has for the establishment of technical co-operation, not simply materially but also in the tradition of service. Something has been done, as Mr. Dickson's paper showed, to promote like traditions and standards of service in technical assistance, but it is unlikely that foreign aid, in the technical or other fields, will yield its full results until such standards have been established and traditions developed at least as much among the recipient countries as among those giving assistance.

The misrepresentation of what is loosely termed 'Colonialism' or 'Imperialism' in the past is no service to the under-developed countries, or to the development of foreign aid. It is the more welcome, therefore, to find not only Mr. Kennan but also other

Americans, such as Mr. Adlai E. Stevenson, taking a more realistic view of this field; although it is perhaps not yet fully appreciated that, as the White Paper itself demonstrates, what is happening to-day in the British Commonwealth is a continuing process that was fully foreseen in 1947 and foreshadowed in its essentials in the early days of Dominion status and the Statute of Westminster. If technical assistance and foreign aid are to contribute towards building a world at peace, in which the new forces at man's disposal, such as nuclear energy, are to be used for the removal of poverty and the elimination of disease and suffering, we must make the fullest possible use of all the constructive organization that already exists. The task of education is enormous, for it will be required in the Western world as well as among the under-developed peoples themselves.

That was obviously a main reason for the conference which President Eisenhower called in Washington on February 25 for the mobilization of public support for the Foreign Aid Programme which he had recommended to Congress; and it is also a reason for welcoming such tributes to the part which the British Colonial system has played in the development of Africa as that, for example, by Mr. J. S. Crossley, in his chairman's address to Barclay's Bank D.C.O. on January 3. President Eisenhower at his conference discussed economic aid in the context of the defence of the free world, and in requesting 2,635 million dollars of military assistance for America's allies and other free nations and 1,307 million dollars for economic assistance, including a further 164 million dollars for technical assistance, he laid his main stress on the security of the United States, some 1,800 million dollars of the military aid being for the supply of 'advanced weapons'. Nevertheless, the technical aid and economic development programme, for the 1,000 million people of the less-developed countries seeking economic as well as political independence, are no less essential, and the President's proposals found powerful support from all parties, Mr. Stevenson suggesting that such economic assistance to under-developed countries should be organized on a world basis. Like Mr. Kennan, he would invite Russian participation, and seek to eliminate waste and competition, with the possibility of one contributor being played against another.

The prospects for the President's proposals are probably much brighter than a year ago. What is clear enough from the objective papers presented at the British Association meeting and elsewhere is the need for much harder thinking about the scale and organization of economic assistance, both technical and otherwise. Proposals like those of Prof. Blackett, or those adopted at a Labour Party conference, to make available for the development of Colonial territories an annual sum equivalent to 1 per cent of the national income, involve difficult problems in execution, in terms of currency and exchange, technical skill and capital goods. Nor is it always, as Mr. D. Blelloch points out in a Fabian pamphlet, "Aid for Development", a matter of lack of technical knowledge in the under-developed countries. Unregenerate, unreformed social systems cannot carry enlightened development programmes.

Neither recipients nor donors can afford the waste that is at present liable to occur of both resources and man-power. The manifest limits to the expansion of the scope of the technical assistance programme strengthen the case for the Special United Nations Fund for Economic Development, and although there are some objections, as Mr. Dickson showed, to channelling all economic aid through the United Nations, the balance might well be in favour of that course. The genuineness or insincerity of some nations' support might thereby be exposed; but, more important, a decisive impetus could be given to the more realistic and creative thinking about the whole organization of technical and economic assistance and to the elimination of waste and overlapping. If the under-developed nations themselves and the world as a whole are to enjoy the full benefit of the sacrifices which the more-developed countries are already making and are prepared to extend, a new approach to the problem is essential.

CONDITIONS OF LIFE IN THE SEA

Treatise on Marine Ecology and Paleoecology

Edited by Joel W. Hedgpeth. Vol. 1: Ecology. (Geological Society of America Memoir No. 67.) Pp. viii+1296. (New York: The Geological Society of America, 1957.) 12.50 dollars.

WE oceanographers, who tend to look askance at the Universal Decimal Classification because it makes marine science a small part of geology, are nevertheless very grateful to geologists, especially those working in the United States, if only for what we get out of them. The Symposium on Marine Sediments, first published by the American Association of Petroleum Geologists in 1939 and reprinted by the Society of Economic Paleontologists and Mineralogists in 1955, is a useful text-book of oceanography, and the new "Treatise on Marine Ecology and Paleoecology" now appearing as one of the memoirs of the Geological Society of America is even more comprehensive, especially in biology and geology.

Vol. 2, on marine palæoecology, came out in March 1957 and Vol. 1 on December 30. They are dedicated to the late Dr. T. Wayland Vaughan, who organized the group responsible for them as a subcommittee on the Ecology of Marine Organisms responsible to the Committee on Geologic Research in the Division of Geology and Geography of the National Research Council, National Academy of Sciences. It made its first annual report in 1941 and soon became a larger committee charged with the task of reviewing marine ecology in relation to palæontology in what is now the Division of Earth Sciences. Harry S. Ladd is chairman of the Committee and Gordon Gunter, Kenneth E. Lohman and Roger Revelle are vice-chairmen for biology, geology and oceanography. There are fifteen other members well known for their work in related fields. Vol. 1, which is reviewed here, was edited by Joel W. Hedgpeth, who writes on marine biogeography and sandy beaches, as well

as contributing to the chapters on estuaries and lagoons and on methods of examination and collection and writing introductory chapters on the classification of marine environments and the concepts of marine ecology. All twenty-nine chapters which fill 1010 pages are by authors well known for their own work. They are followed by 217 pages of annotated bibliographies and 70 pages of two-column index.

The members of the committee were well aware of complaints about the jargon of ecology, and while demonstrating the usefulness of some specialized terminology they try to use as little as possible; in classifying environments they try to develop a scheme which will be acceptable to as many workers as possible and not upset well-established usages. They are careful to define the special terms and show that ecology, the study of interactions between organisms and environment in the living world, merits a name of its own in the field of natural history.

Dr. Hedgpeth gives an interesting introduction to the subject. It developed largely through studies of shore problems and intertidal zonation, but if the idea is followed back, Forbes's "Natural History of the European Seas" can be regarded as the first treatise on marine ecology. The United Kingdom has been a fertile ground for it; we are reminded of the strange heights reached by the fever of seashore study in Victorian days, and that we had the first government commission to study fisheries. The growth of the subject is summarized; it is emphasized that studies in systematic zoology and botany are a necessary preliminary to critical work in it, and there is a fine tribute to the work of the Plymouth Laboratory.

He tells us, however, "It is, of course, sometimes necessary to conduct an ecological investigation in a remote region without knowing the species involved; careful workers, however, will make every effort to get their species identified before publishing their results"; by putting it so kindly he will no doubt prevent a good deal of future exasperation.

All the chapters are remarkably complete and up to date, with detailed references. Wheeler's parachute net, Motoda's vertical successive sampler, the orange peel bucket and the Isaacs Kidd trawl are a few recherché items from the chapter on methods. The reader is warned that "we do not intend to minimize the importance of physical and chemical data in ecological investigations, of course, but it must never be forgotten that an ecological investigation is essentially an investigation of organisms *in situ* and physical and chemical information without specific reference to organisms is the stuff of meteorology and hydrography, not ecology". Fortunately, the contributors also have a sense of humour and the chapters on solar radiation, salinity, temperature, oxygen, carbonates and trace metals, though bearing the warning in mind, are remarkably comprehensive and informative.

The chapters on interrelations of organisms, biogeography, plankton, estuaries and lagoons, deep sea and abyssal depths, sandy beaches, rocky shores, coral reefs, and submarine canyons and bottom communities seem quite exhaustive as well as devoted to the examination of the relations between the animals and their surroundings. There are a chapter on particulate organic detritus and special accounts of the Baltic Sea, Black Sea and Sea of Azov, and the Caspian and Aral Seas. An account of lunar periodicity by P. Korringa suggests that most of the apparent effects on the breeding of animals can be explained by the variations in the tides and moonlight, and is rather down on "anthroposophists". W. R. Coe gives a useful summary of work on the fluctuations in littoral populations and Mrs. Brongersma-Sanders a very complete account of all that has been done on mass mortality in the sea.

I feel that the "Treatise" is a tremendous success. In spite of its encyclopædic nature it is readable, and the editor himself does a good deal to leaven the 1,296 pages. Attempts like those of Dr. Pantin to restore the spelling of littoral to the etymologically correct 'litoral' would, he feels, be tilting at windmills; there is no mention of 'oecology'.

When he asks what sorts of tools will be used in the future one is tempted to press the claims of physics, which regulates the building of the house as well as making the dwellers feel at home. There is, for example, growing evidence that the real factor which governs the success of a marine population is sometimes the steadiness of the water circulation rather than the temperature range associated with it. Can we hope that the Committee and the Geological Society of America will in good time make as determined an attack on this aspect as they have on the others?

G. E. R. Deacon

ARCHÆOLOGY IN GREECE

The Annual of the British School at Athens

No. 50, 1955. Pp. viii+280+53 plates. No. 51, 1956. Pp. viii+176+43 plates. (London: The British School at Athens, 1956 and 1958.) Each 63*s*. net.

THE first of these volumes is not quite so specialized as usual, though few students (even of archæology) will want to read it all.

D. M. Lewis continues his learned commentaries on Attic inscriptions: the most generally interesting adds point (if that were needed) to Aristophanes' "Lysistrata". T. B. L. Webster with slippery logic maintains that the Geometric vase-painting of Athens drew largely on epic. J. Boardman carefully studies painted Attic plaques from tombs and makes some sensible observations on funeral ceremonies in the Archaic period. L. H. Jeffery deploys a neat scholarship on a wide variety of early inscriptions. G. E. Bean and J. M. Cook report on their arduous and successful survey of the Halicarnassus peninsula: it is surprising that there were so many sites still needing identification. A. J. B. Wace and his adjutants offer further instalments on Mycenae: Wace chose with care the spots to excavate and his finds were, as always, relevant and important. P. Corbett and G. Woodhead collect a number of fragments of pottery bearing forged inscriptions, some of which have deceived experts. R. M. Cook argues unkindly that though Thucydides observed archæological remains he misunderstood them. Lastly, A. M. Woodward offers some notes on fragmentary inscriptions of Athenian decrees.

Vol. 51 concentrates on prehistory (which in Greece is reckoned as ending with the Bronze Age) and on epigraphy (that is, the study of inscriptions of the Iron Age). These are now specialized fields from which most Classical archæologists shy away. The prehistorians here are concerned with the Late Bronze Age. K. Scholes has investigated the Cyclades, where she found some new sites, and usefully reclassifies the pottery. R. W. Hutchinson describes two Cretan tombs, one a chamber tomb

and the other of the *tholos* (or beehive) type frequent in Greece but not in Crete. M. S. F. Hood supplies a detailed commentary on another, well-stocked Cretan chamber tomb. M. Pope offers the cryptographers four Cretan axe-heads with inscriptions in the undeciphered 'Linear *A*' writing. A. J. B. Wace reports on his last campaign at Mycenae in 1955 with important observations on the 'Treasury of Atreus', the houses and the palace; V. R. d'A. Desborough adds an account on two graves of the early Iron Age, one containing what may be the first Hellenic lamp yet recognized. In epigraphy, A. M. Woodward continues his notes on Athenian inscriptions. G. E. Bean reports on a foray into the south-west of Hellenistic and Roman Turkey. L. H. Jeffery contributes a new and improved publication of an inscription of the sixth century B.C. from Chios, the earliest document of democracy, whatever that political term meant. W. G. Forrest does some ingenious calculations about liquid measures in Chios. J. Boardman offers variety: first he gives a judicious account of a not very productive excavation at Delphinion in Chios, then he puts a partisan case for the making of fine Greek pottery at Naucratis in Egypt.

The British School at Athens with old-fashioned good sense publishes its "Annual" with a stout binding. The printing, too, is good and the illustrations are generous.

R. M. Cook

THERMAL ANALYSIS OF CLAYS

The Differential Thermal Investigation of Clays

Edited by Robert C. Mackenzie. Pp. xii+456. (London: Mineralogical Society, 1957.) 60*s*.; 9 dollars.

THIS volume has been prepared by the Clay Minerals Group of the Mineralogical Society as a companion or complementary work to its "X-Ray Identification and Crystal Structures of Clay Minerals", which appeared in 1951 (see *Nature*, 170, 337; 1952). It differs from the latter in one respect, however, for it considers not only the clay minerals, but also the minerals in clays. Since clays and other raw materials, to which the methods of differential thermal analysis described are applicable, are very frequently not mono-mineralic, this widening of the field covered is important.

As the editor points out, recognition of the importance of thermal properties in the identification of minerals is by no means a new conception, for it goes back to the eighteenth century. That important developments did not take place until many years later was due to the difficulties in applying the conception with success. These were, originally, the inaccuracies of early pyrometry and, in the case of the clay minerals especially, the small size of clay particles. As with other sciences, important advances have followed improvements in the technical methods of investigation; and a major advance was initiated by Le Chatelier, who developed the thermocouple as an accurate means of measuring temperature, and applied it to the investigation of certain clay minerals in 1887. From time to time, since then, further progress was made; but it is only in the past thirty or so years, during which time the basic structures of most of the clay minerals have become known, that the method has come into general use. Although at present X-ray diffraction is admittedly the most valuable single method for the investigation of clay mineralogy, differential thermal analysis of clay minerals, and raw materials containing clay minerals, has grown rapidly in importance as an auxiliary method of investigation.

This study of the subject has been prepared under the general editorship of Dr. R. C. Mackenzie of the Macaulay Institute for Soil Research, Aberdeen, but there are twenty-two contributors, from various research centres, in Great Britain and abroad, who have made special studies of different aspects of the subject. Dr. Mackenzie contributes an introductory chapter on the various thermal methods now in use. The next two chapters deal with the apparatus and techniques employed, and with the theoretical and quantitative interpretation of results. There follow twelve chapters on particular mineral groups, including, as well as the minerals generally recognized as clay minerals: the various forms of silica; oxides of iron, aluminium and manganese; carbonates; and 'other minerals', such as certain sulphides, halides, phosphates, etc. There is also a chapter on carbonaceous materials, which may assume importance as impurities in, for example, fireclays and ball clays. The final chapter discusses the technical applications of differential thermal analysis for soil science, geology, and the ceramic, chemical and mining industries. Each chapter concludes with a bibliography.

The information here brought together has been derived from many scattered sources, including original papers written in languages other than English. The book forms a valuable work of reference which must prove useful to research workers in a number of fields, and the authors and editor are to be congratulated on its production.

A UNIFIED SCIENCE OF LIFE

Life

An Introduction to Biology. By George Gaylord Simpson, Colin S. Pittendrigh and Lewis H. Tiffany. Pp. xiv+845. (London: Routledge and Kegan Paul, Ltd., 1958.) 50*s*. net.

AMERICAN writers have a remarkable facility either for producing precise works of magnificent quality or verbose volumes which have little appeal in Great Britain. "Life" belongs to the former group and bears comparison with any text-book of biology yet produced in the English language. Other authors have attempted to produce a unified science of biology but have achieved little more than an illicit union of botany and zoology. The authors of "Life" believe that general biology has a body of established and working principles and that every rational human being should have a basic acquaintance with these principles. These principles are given considerable prominence throughout the text, and supporting facts are used to show how the principles arise from them.

The book is divided into nine main sections. After an introductory section, which makes a survey of the living world, the place of biology in the whole field of science is considered and this leads to a description of the foundations of modern biology. Then follow accounts of the unit of living organization, of how organisms are maintained and integrated, the continuity of life, the mechanisms of evolution, the amazing diversity of living organisms, the life of

populations and communities and the history of life. Although one section is entirely devoted to accounts of evolution and its theories, the whole of the text is interwoven with that evolutionary thread which is the most general principle yet evolved in biology. Throughout the text, too, the authors show how scientists approach problems and how, through a historical approach, important biological problems have been completely or partially solved.

The text is as free from technicalities as such a book could be. Where technical terms contribute to easier communication and comprehension of principles they are used; where unnecessary they are omitted in favour of language which can be easily followed by the non-specialist reader. In many cases additional terminology is added to figures and legends where the reader may take it or leave it. In this way the authors can rightfully claim that they have produced a book which has been written neither for the non-professional student of biology nor for the student who is beginning a professional career but for both.

Unstinted praise does not mean that the book is free from blemish. Despite a ready facility to illustrate a principle with examples drawn from the plant or animal kingdoms according to which is most suitable, the authors lean much more heavily on the zoological than on the botanical sciences. Despite the not unsuccessful efforts to use the whole of the text to illustrate the principle of evolution, many general readers would have gained more if the section on the diversity of life had been inserted much earlier in the book. It would be difficult for the unacquainted to see where certain organisms fit into the evolving pattern of life without knowing something of the organisms themselves. The chapter on the history of biology is fragmentary, and would not have been missed had it been omitted.

Yet these are criticisms which are of a minor nature in a work of such superb quality. The text is lavishly adorned with photographs and line-drawings of extraordinary merit; the latter are reminiscent of those which have long illuminated the books of a well-known British writer of botanical works.

"Life" is a remarkable achievement which would be invaluable to those who wish to make themselves familiar with the general principles of biology before going on to specialize in botany, zoology, biochemistry or any other life science.

PROPERTIES OF DISLOCATIONS

Dislocations and Mechanical Properties of Crystals

An International Conference held at Lake Placid, September 6–8, 1956. Edited by J. C. Fisher, W. G. Johnston, R. Thompson and T. Vreeland, Jr. Pp. xiv+634. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 120*s*. net.

Les Dislocations

Par J. Friedel. (Monographies de Chimie Physique.) Pp. viii+314. (Paris: Gauthier-Villars, 1956.) Broché, 3,500 francs; Cartonné, 3,800 francs.

THE general properties of dislocations are discussed in a number of books, but the subject now includes a number of distinguishable branches each covering a formidable body of work and requiring separate detailed treatment. The report of the international conference on dislocations and the mechanical properties of solids may be considered a standard text on its subject.

Just as the transistor experiments gave many people a clear physical picture of the behaviour of holes and electrons in solids, so the series of beautiful experiments here recorded makes dislocations seem quite familiar: not only have individual dislocations been made visible by a variety of techniques, but also they appear in motion pictures.

The book is divided into eight sections some of which are introduced by review papers with detailed references to the original work: they deal with (1) direct observations of dislocations; (2) deformation of pure single crystals; (3) work-hardening and recovery; (4) alloy crystals, impurities, yield point phenomena; (5) dislocation damping and fatigue; (6) theory of dislocations; (7) whiskers and thin crystals; (8) radiation damage. The several sections include a series of discussions of the relations between dislocations and defects on the scale of one or a few atoms. The properties of dislocations in organic crystals, linear polymers and planar structures are not among the subjects discussed. The volume is well produced and illustrated, and an index is provided.

"Les Dislocations" is of the standard of a final-year university text, if somewhat specialized in character, and is intended by its author to provide, for the French reader, a survey of the principal properties of dislocations. This it does, but it would not seem particularly easy to follow as an introduction to the subject. Perhaps more adequate illustrations would have helped, as the complexity of the subject is such that a clear physical picture of dislocations is essential if it is to be understood.

R. A. Hyman

THE RADIO UNIVERSE

The Exploration of Space by Radio

By R. Hanbury Brown and Prof. A. C. B. Lovell. Pp. xii+207+21 plates. (London: Chapman and Hall, Ltd., 1957.) 35*s*. net.

ASTRONOMY is the oldest of the sciences, but it is a science which becomes younger as time goes on. It is not long since the universe was merely a spherical surface on which the various heavenly bodies moved in an orderly but complicated manner: now it is a field of exploration, inexpressibly remote but accessible by interpretation of the signals it sends to us in the form of electromagnetic waves. The spectrum of the cosmic radio waves contains a surprisingly small amount of energy, and in comparison with light waves it would be reasonable to expect that the information that radio waves can give us about the universe would be slight indeed. This young science of radio-astronomy has nevertheless revealed to us a new universe, in which visible objects are almost insignificant, while faint nebulæ containing thin gas clouds radiate such strong radio signals that the sky seen by radio-telescopes has a quite unfamiliar appearance.

The first successful radio-telescope was a steerable array of dipoles used for investigating the noise-levels of short-wave radio communications. Radio-telescopes have grown with the new subject; in August 1957 the great parabolic reflector at Jodrell Bank was first used for recording cosmic radio waves. This wonderful and versatile instrument was completed just 25 years after the publication of Jansky's first

observations, and it has come at a time when radio-astronomy is growing so fast that it is becoming hard to see the subject as a whole.

It is singularly appropriate that it is at this time that Lovell and Hanbury Brown, who have been responsible for so much of the fine work at Jodrell Bank, have written a book which reviews the present state of our exploration of the radio universe. This, one feels, is the result of a pause for reflexion, in which the programme of the new radio-telescope has been considered in relation to the many branches of the subject. The book is for that reason concerned with considerable detail, offering some reward to the serious student; the main purpose of displaying the results and possibilities of the methods developed in the past few years is, however, in no way obscured by technicalities.

For the newcomer the first three chapters provide a background outline of the universe as we know it at present, and an outline of the techniques of radio-astronomy (we note incidentally an exceedingly diverting Fig. 33, which contains the only obvious error in the book). The distribution of the subject-matter over the main part of the book very naturally reflects to some extent the especial range of interests of Jodrell Bank. The chapter on meteors represents one of the best accounts available of the Manchester work, and naturally carries more weight than the rather shorter chapter on solar radio waves. Galactic and extragalactic radio emissions occupy less space than one could have hoped for, but there is little chance for expansion of this part of the universe when space must be found for the hydrogen line, scintillation, aurora, and the moon and planets.

The last chapter is devoted to the Jodrell Bank radio-telescope, of which we may all be justly proud. We wish the authors of this book all success in their new explorations of the radio universe.

F. G. Smith

AMAZON FOREST

Wai-Wai

Through the Forests North of the Amazon. By Nicholas Guppy. Pp. xii+375+20 plates. (London: John Murray (Publishers), Ltd., 1958.) 28*s*. net.

IN 1952 Mr. N. Guppy, then an official of the Forestry Department in British Guiana, set off on a journey of exploration and research in the little-known areas of the extreme south of the Colony and the adjacent regions of northern Brazil. He went to the New River, a tributary of the Courantyne, to the Mapuera River, a tributary of the Amazon, and across the mountain range which separates the two river systems of Guiana and Amazonia. "Wai-Wai" is the account of this journey, the incidents in which he was involved, the American Indians whom he encountered there, and the type of countryside which it was his official task to investigate and record. The book is beautifully written, with excellent photographs and a useful index and glossary.

"Wai-Wai" is one more in the stream of books of exploration in remote parts of South America, but it has certain qualities which, in my opinion, raise it above the majority of its fellows. It is the best account of the South American tropical forest that I have read; the descriptions capture all the impressions of the forest, while managing at the same time to give a business-like exposition on various botanical species and their characteristics. The forest is portrayed by a botanist with a poetic eye. To harmonize the romantic and the scientific and at the same time to convey the reality in print is no mean feat.

The mythical 'snake-infested and steaming jungle' of South American exploration is ignored, and instead the book describes the cool, dim rain-forest of reality, outwardly monotonous but, under examination, full of the most exciting products of Nature. It is a forest in which the intruder is more likely to twist an ankle on tree roots than to be bitten by a snake, to be lost rather than set on by warlike Indians, to suffer from infestation by fleas instead of being attacked by dangerous animals and, above all else, to be called on to endure the consequences of inadequate diet.

In too many books the authors claim to be the first in an unknown area and conveniently ignore previous explorers, missionaries and officials who may have opened the way. Mr. Guppy's claim that his area is largely unexplored is not only true but is also generously reinforced by specific references, from his own literary research, to those few travellers who did manage to penetrate it before his own visit. Information about past attempts at exploration and present missionary efforts adds much to the interest of the book and by no means detract from the author's own achievements.

There is a refreshing approach to the old legends of lost cities in the jungle, Amazons, white Indians and the oft-repeated assertions that Indian customs indicate the previous existence of a great civilization, now forgotten. Mr. Guppy looks sensibly at the forest environment and the type of society which characterizes the small Indian tribes, and provides his own answer to these exotic notions. For him the fruits of exploration are not lost cities or the settlements of those warlike ladies who gave their name to the region, but the gentler rewards of the discovery of a new variety of tree species, the reconstruction of the primeval forest landscape and the forces which worked on it and the understanding of the very human and likeable Wai-Wai and Mawayán tribesfolk.

One of the most interesting, and most controversial, portions of the book is the discussion and analysis of Wai-Wai Indian art. To substantiate his assertion that their art is proceeding from the realistic to the abstract would, I feel, require a longer period of personal contact with the people and possibly a knowledge of their language in order to get a direct point of view. To venture to account for such a change in style would also require the most widespread comparative studies. Mr. Guppy's opinions should not be taken for anything more serious than tentative hypotheses for future research to prove or disprove.

This book will appeal to all those who enjoy a well-written, intelligent and accurate account of a journey of exploration and research. It is the best literary introduction to life in a tropical forest that I know, and as such I recommend it to anyone who wishes to know about or to try this sort of life for himself. Although experts will regret the lack of more detailed information in their own particular spheres of interest, it is a measure of Mr. Guppy's success that he should arouse this interest in the reader; his work should provide the basis for future intensive research in this most interesting region of South America.

Audrey J. Butt

Archives de l'Institut de Paléontologie Humaine, Paris

Mémoire 28 : La Grotte de Fontéchevade. Première Partie : Historique, Fouilles, Stratigraphie, Archéologie. Par G. Henri-Martin. Pp. 288+10 planches. (Paris : Masson et Cie., 1957.)

FONTÉCHEVADE is a Palæolithic cave-site in the Charente department of France, where Mlle. Henri-Martin has been working for some years, and prehistorians have waited a long time for publication. This first 300-page volume deals with the history of the site, with the various digs which have taken place, with the stratigraphy of the section, and with a description of the industries unearthed from the various levels. This work worthily upholds the high standard we have learnt to expect from the volumes of the Archives de l'Institut de Paléontologie Humaine. Naturally the position of the human remains in the section is given, but no account of the remains themselves. Doubtless such an account has been reserved for a future specialist work. Several excavators have tried their hand at Fontéchevade, but it was only during more recent digs that it was realized that the apparent bottom was not the real rock base of the shelter, and so a whole new series of levels came to light. Industries belonging to two main cultures are present, Mousterian with Tayacian below. Over the Mousterian a little Upper Aurignacian was found.

A somewhat odd, very roughly made series of industries intercalated with the end phase of the Acheulean has long been recognized at La Micoque, and similar industries have been found in other places, notably at Tayac. But the Tayacian as a culture has always seemed somewhat elusive and the industries hard to describe or to compare with those of any other culture. But now at Fontéchevade two layers of Tayacian occur in stratigraphical sequence below two typical Mousterian levels, the lower one being early with some Acheulean tradition. Actually, the human remains come from one of the Tayacian levels and their date is therefore certain. No hearth or evidence of careful burial could be observed. The whole volume is important, but perhaps the chapter descriptive of the Tayacian industries can be especially mentioned. A large number of well-drawn illustrations in the text help the student to get an idea of what these industries are really like. There is also an interesting discussion of the use of bone by Tayacian man, and what sort of bone was preferred. The other cultures present have not been forgotten, and a detailed account of their industries duly appears. No prehistorian can afford to neglect this important contribution to our knowledge of prehistoric man.

M. C. Burkitt

The Invertebrata

A Manual for the Use of Students. By the late L. A. Borradaile and F. A. Potts. With Chapters by Prof. L. E. S. Eastham and J. T. Saunders. Third edition revised by G. A. Kerkut. Pp. xvii+795. (Cambridge : At the University Press, 1958.) 55*s*. net.

THE appearance of a revised third edition of 'BEPS', as this manual on the Invertebrata is affectionately called by English-speaking zoologists, was awaited with great expectations. In the twenty-three years that have elapsed since the publication of the second edition, some of the more recent ideas on the phylogeny and classification of the Invertebrata have become more widely accepted, and other well-established ones have had to be thrown into the melting pot in the light of new and sometimes startling discoveries which have recently enlivened the scene of invertebrate morphology.

In the new edition, note has been taken of this as well as of the necessity for quite a number of overdue improvements in text and illustrations. Of the seventy additional pages, twenty-three are devoted to a most welcome chapter on literature. There are certain gaps, but the selection of recommended reading matter represents a most useful guide to the student.

More than a hundred new illustrations have been added. Many are didactically well conceived, but quite a number of them suffer from an almost deliberate carelessness in execution, a fault that is frequently accentuated by a windblown alignment on the page. The insertion of labels on the text-figures scarcely ever interferes with clarity and does away with the tedium of deciphering abbreviations by means of lengthy legends.

The sections on the Nemertea, Nematoda, Araneida and Onychophora have been expanded, and the chapter on the Insecta has been completely rewritten by Prof. Eastham and supplemented with a number of useful new text-figures.

A book of this kind is bound to contain many half-truths and even outright mistakes, but to quote what, one hopes, may be an extreme case, the account of the Trematoda contains so great a number of inaccuracies as to make one question its usefulness to the undergraduate student. However, on the whole, the work bears witness to the revisers' sound judgment and didactic enthusiasm. They ought also to be congratulated on having successfully resisted the temptation to disrupt the morphological story unduly by insertion of specialized physiological, behavioural, and ecological information. Thus this great text-book was made to remain true to its original conception. There is a good index.

O. Lowenstein

Passive Network Synthesis

By Dr. James E. Storer. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. x+319. (London : McGraw-Hill Publishing Company, Ltd., 1957.) 64*s*.

THERE is, it would seem, almost a fashionable demand these days for books on network synthesis as distinct from analysis, for the reason, of course, that by comparison the latter has found much more ready authorship for decades past and, in consequence, is more deeply entrenched. Synthesis, however, is coming into its own, although its methods relate principally to the telecommunication class of networks.

In the present book the author provides a concise survey of the field of modern synthesis methods, each procedure being illustrated with numerical examples. The text is in four parts which relate respectively to impedance synthesis, network synthesis using image parameters, modern realization methods for two-terminal-pair networks, and rational-fraction approximations. Linear networks containing lumped elements only are covered, and for these the mathematics required does not exceed the standard of the operational methods commonly employed in network theory.

Having in mind the stated scope of the work, it is one that can well be recommended as an introduction to more advanced studies.

S. A. Stigant

HUMAN SOMATIC CHROMOSOMES

By Dr. C. E. FORD and P. A. JACOBS*

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AND

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UNTIL 1956 it was generally believed that the diploid chromosome number of man was 48. Early in that year, however, Tjio and Levan[1] reported consistent counts of 46 chromosomes in tissue-cultures established from four aborted embryos, and shortly afterwards their counts were confirmed in testicular preparations[2]. Since then, the number 46 has been found in cultures of normal human tissues by others[3,4]. On the other hand, Kodani[5] recently examined testicular material from 21 Japanese men and claimed that in 16 of them the diploid number was 48, in one of them 47, and in four, 46. He accepted 46 as the basic human diploid number and believed that the additional chromosomes are similar to the 'inert' supernumerary chromosomes found in many plant species and some invertebrates[3,7]. Such supernumerary chromosomes are usually small and often heterochromatic; they have very little genetic effect (if any can be detected at all); it is common for them to be absent from some populations of a species and present in others; and when they are present the numbers in different individuals usually conform to a Poisson distribution. We are unaware of any other reported instance of the occurrence of 'inert' supernumerary chromosomes among the vertebrates, although numerical polymorphism of a different type is now known to be present in some populations of two mammalian species[8,9].

Apart from the need to establish whether such supernumerary chromosomes do or do not occur in Europeans, there are several reasons why a better knowledge of human somatic chromosomes is to be desired. If the cytogenetic analysis of human cancers and leukæmias is to progress, definition of the normal chromosome set will be required as the basic reference point; recognition of the *X* and *Y* chromosomes in somatic mitosis would offer the possibility of direct identification of the genetic sex of intersexual individuals and so provide a crucial test of the interpretation placed on the 'sex chromatin' by Barr and Bertram[10]; and the new information would perhaps serve to re-awaken interest in the value of a detailed comparison between the chromosomes of man and of the great apes.

Very satisfactory Feulgen-squash preparations can often be obtained from the bone marrow of experimental animals which have been injected with colchicine to arrest the dividing cells at metaphase and to help to disperse the chromosomes[11]. The results reported here were obtained in the course of an attempt to adapt this procedure for use with human marrow cells obtained by sternal puncture, the particular end in view being a method by which reliable observations of the chromosomes of human leukæmic cells could be made. The main difficulty was that colchicine was not injected into the patient but had to be applied to the cells after removal from the body. This was done by making use of the short-term culture method for myeloid cells developed by one of us[12]. The sternal puncture specimens were dispersed in Ringer's solution containing heparin (1 : 20,000); the cells were spun down and the supernatant fluid removed; they were then resuspended in glucose saline plus normal human AB serum and transferred in 2–4 ml. aliquots to 1-ounce McCartney bottles. At this stage the cultures were transferred from Oxford to Harwell, where they were usually allowed to stand in the laboratory overnight before being incubated in a 37° C. water-bath for 5–15 hr., the last few hours of which were in the presence of added colchicine. The most satisfactory combination of the technical variables so far tested was 7 hr. total incubation, with the addition after 5 hr. of 0·2–0·4 ml. of a solution of 0·04 per cent colchicine made up in glucose–saline (0·6 per cent glucose and 0·7 per cent sodium chloride). At the end of the incubation period sufficient 0·37 per cent sodium citrate solution was injected into the bottle to give a 4-fold dilution of the medium. After 10 min. the cells were fixed and thereafter the procedure closely followed that already described[11]. An alternative method, which gave some good preparations, was to squash fixed but unstained cells suspended in 45 per cent acetic acid, freeze on solid carbon dioxide, remove the cover-glass and then stain briefly with acetic–orcein. In this way the hardening effect of the orcein on the cytoplasm was avoided.

The original marrow specimens were taken for normal clinical purposes at the Churchill Hospital. Cultures from 30 patients were received at Harwell and useful information was obtained from 23 of them, of which one, derived from a leukæmic case, was exceptional and will be mentioned in discussion only.

The first aim of the cytological examination of each specimen was to determine the diploid number. The chromosome-counts recorded are summarized in Table 1, which shows that modes at 46 were found in all the 14 specimens for which full data are given. The same was true of the counts made on the eight further specimens which are shown combined in the table.

The next step was to try to identify the sex chromosomes. To make the search more objective, the sex of the specimen was not revealed to the observers until their examination was completed. The *Y* chromosome was known from observations at first spermatocyte metaphase[3] to be one of the

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Table 1. Counts of Chromosomes in Human Bone Marrow Cells and Chromosomal Diagnosis of Sex

Case	Cells counted	Counts									Sex		Clinical condition
		≤ 42	43	44	45	46	47	48	49	≥50	True	Diagnosed	
10	34	1	1	4	4	22	2				♀	♀	Pregnancy anæmia
12	50	2	4	6	3	27	3	2	1	2	♂	♂	Iron deficiency anæmia
14	70	6	1	9	9	43	1			1	♀	♀	Pernicious anæmia
15	15			1	1	13					♀	♀	Iron deficiency anæmia
19	17			1	1	5	3	2	1	4	♂	♂ ?	Iron deficiency anæmia
24	94	3		4	7	73	3	2	1	1	♀	♀	Undiagnosed fever (very active normal marrow)
26	27	1		2	2	17	3	1	1		□	♀ ?	Pregnancy anæmia
30	22			1	3	15	2			1	♂	♀ ?	Polycythæmia vera
34	24				4	17	2			1	♀	♀	Lymphocytic leukæmia
35	35	1			4	22	3	2	1	2	♂	♂	Hæmolytic anæmia
36	47	4		1	8	34					♀	♀	Iron deficiency anæmia
38	22	2	1	1	3	13		2			♀	♀	Pregnancy anæmia
43	28	1	1	2		19	4	1			♀	♀	Pernicious anæmia
44	26	1		1	1	22		1			♀	♀	Blast cell leukæmia
8 others	44	3	1	3	4	25	5	2	1				
Total	555	25	9	36	54	367	31	15	6	12			

smallest chromosomes and probably to have a terminal or nearly terminal centromere. An attempt was therefore made to match the smallest members of the complement in pairs, and so, by elimination, to identify the *Y*. In several cells of the first specimen (case 10) it was found that the smallest twenty elements could be clearly separated according to size and the position of the centromere into groups of four, four, two, four and six, respectively (cf. Fig. 3). The first four and the last six were acrocentric chromosomes, the latter group being sharply distinguished from the next larger chromosomes both in length and position of centromere. An identical set of twenty small chromosomes was identified in the second specimen also (case 12). There was, however, one additional acrocentric chromosome which was not clearly distinguishable from the group of smallest four chromosomes. The obvious inference was that this was the *Y*. On reference to the Churchill Hospital it was found that case 10 was indeed a female and case 12 a male, as expected. Thereafter, so far as possible, all specimens were sexed by the presence or absence of the fifth small acrocentric chromosome. Sex was correctly diagnosed in the thirteen cases from which at least four cells were analysed in detail, although only two of them were males (cf. Table 1). In two of six other cases a tentative opinion based on the analysis of one and of two cells, respectively, was wrong. In the remaining three cases the preparations were not good enough for identification of the small chromosomes to be attempted.

Once the characteristics of the smallest ten pairs had been well learned the remaining chromosomes were examined more closely. It was found that in most cells the longest ten elements could readily be separated into five individual pairs. There then remained sixteen (fifteen in males) medium-length elements with sub-median or sub-terminal centromeres. These were much more difficult to match, but a tentative sub-grouping proved to be possible in a small number of exceptionally favourable cells. Unfortunately, nearly all these were in preparations from females, so that the *X* chromosome, which must fall in this group, remains unidentified. Photographs of two cells, one from a male and one from a female, are reproduced in Figs. 1 and 2. The small acrocentric chromosomes on which the identification of sex depends are indicated by arrows. Fig. 3 is a diagram showing the relative lengths of the chromosomes and positions of the centromeres.

The constancy or otherwise of the chromosome number in somatic tissues of vertebrates has been a matter of controversy[12]. Taken at face value the counts shown in Table 1 would seem to demonstrate extensive variation. However, we are not convinced that there is any true departure from the number 46, apart from occasional polyploid cells, in the preparations of bone marrow we have examined. Errors could have arisen in three ways: (1) Through counting the chromosomes in cells where interpretation was difficult owing to inadequate fixation, staining and spreading of the chromosomes. Many such cells were accepted for scoring in view of the value of the material and the general scarcity of mitoses. (2) Early division of the centromeres (giving 'colchicine-anaphases') was frequent. This hampered interpretation in some otherwise 'good' cells, so that structures counted as two separate bodies might sometimes have been the two chromatids of one chromosome. (3) Cells are always liable to be ruptured in squash preparations and consequently to lose fragments of cytoplasm

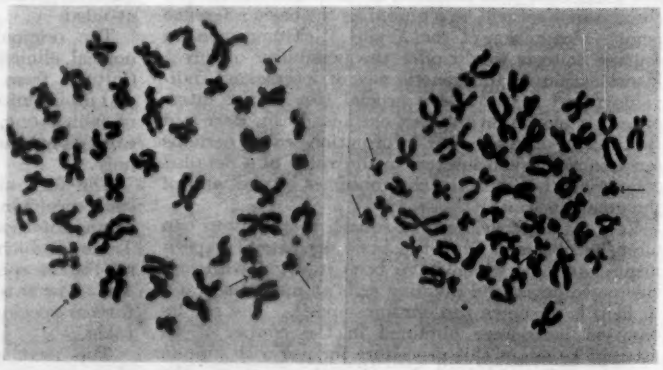

Fig. 1 Fig. 2

Figs. 1 and 2. Chromosomes at metaphase in human myeloid cells after colchicine treatment. Acetic-orcein squash preparations (× 1,700). Fig. 1: from a female—four small acrocentric chromosomes (arrows). Fig. 2: from a male—five small acrocentric chromosomes (arrows)

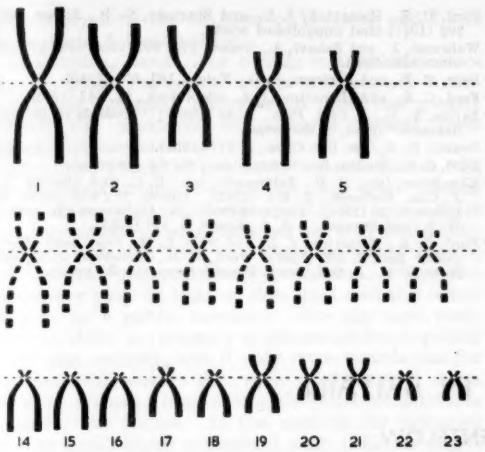

Fig. 3. Diagram of the human (European female) haploid chromosome-complement based on measurements of the individual chromosome-arms. Chromosomes which can usually be identified with confidence shown in black. The largest chromosomes measure about 7μ at metaphase and the shortest about 1μ

containing one or more chromosomes. It is significant that the count was nearly always 46, and never greater, in apparently diploid cells where a detailed analysis of the chromosomes was possible and where there was no suspicion of cytoplasmic fracture. If there is real variation it has to be remembered that all the specimens were in one way or another pathological and that abnormalities might arise and persist which would not occur in a normal healthy individual. Such deviation from the normal is known to occur in malignant tissues, and, indeed, was found in the leukæmic marrow to be mentioned below. On the other hand, the fact that the same modal count of 46 was recorded from twenty-two different individuals and that in all the cells fully analysed we were able to identify by their morphology the twenty (twenty-one in males) smallest chromosomes is evidence that we have been observing essentially normal human somatic chromosome sets, notwithstanding the pathological origin of the material.

The number of instances in which the diploid number 46 (or the haploid number 23) has been recorded in human cells is growing steadily. Excluding Kodani's four examples[5], counts relating to nine individuals have been published[1–4]. To these may now be added the twenty-two reported here. Dr. J. H. Tjio, Dr. J. G. Gall and Dr. E. A. McCullogh have each kindly allowed us to quote their independent, unpublished (and in the last case, preliminary) observations made on preparations from tissue-cultures. These contribute a further fifteen cases. We are also indebted to Mr. J. L. Hamerton and Dr. U. Mittwoch for permission to state that they have counted twenty-three bivalents in primary spermatocytes from five and from three men, respectively. The same number was found in six further testicular specimens examined at Harwell. There is therefore a total of sixty human individuals in which the chromosome number has been determined to be $2n = 46$. All our cases and those of Hamerton and Mittwoch were Whites, and so far as we know so were the remainder, except for one Negro. The recent work, therefore, provides no evidence that supernumerary chromosomes occur in White populations.

The fact that sex was correctly diagnosed from the chromosomes in seventeen out of nineteen cases, including all thirteen in which the diagnosis was based on four or more cells, is good evidence that the presence or absence of the *Y* chromosome can be detected. The way is therefore open for a direct test of the validity of the diagnosis of the genetic sex of intersexual individuals by the presence or absence of 'sex chromatin'[14]. In fact, at the request of Dr. W. M. Davidson and Dr. D. Robertson Smith of King's College Hospital, London (with whom a detailed account will be published later), we have examined a sternal puncture specimen from a case of Klinefelter's syndrome[15]. Persons displaying this syndrome present an essentially male appearance but have small testes in which spermatogenesis is rarely found. The unique interest of these cases stems from the fact that many of them exhibit chromatin-positive nuclei in skin biopsy specimens, buccal smears, and blood films, and on this basis are considered to be genetic females. The case examined was one of this type. Only five favourable cells in metaphase were found, but of these four were of the female type and the fifth was classified as probably female. In this first test, therefore, there is agreement between the diagnoses of genetic sex by the presence of 'sex-chromatin' and by direct examination of the chromosomes.

Twelve of the thirty marrow specimens were from leukæmic patients and in nine of them (lymphocytic leukæmias and undifferentiated blast-cell leukæmias) the frequency of mitosis was so low that we were able to obtain very few counts or none at all. The few cells that were examined gave no indication of chromosomal abnormality and it is possible that they were normal marrow cells. The other three specimens were from more active leukæmic marrows. In two of them (cases 34 and 44, Table 1) there was again no evident departure from the normal chromosome number and morphology, and since in the latter case a smear made directly from the sternal puncture specimen showed 90 per cent of leukæmic blast-cells, many of them in mitosis, it can scarcely be supposed that in culture, some 24 hr. later, all the dividing cells were derived from the 10 per cent of normal myeloid tissue. The other specimen (case 41), however, was clearly abnormal cytologically. Most of the cells contained 44 chromosomes plus an additional minute fragment. In a few cells 88 chromosomes were counted plus two identical fragments. Analysis of this material is incomplete, but it appears that one of the pairs of long metacentric chromosomes (No. 1 in Fig. 3) is absent and that there are deviations from normal morphology among the smallest members of the normal set. This is not the place to discuss the significance of these changes and a full report of the case will be published elsewhere. It is of interest, however, that in this first human leukæmia to show an abnormal yet individual chromosomal pattern the modal number should be *hypo*diploid, whereas in murine leukæmias the mode is very frequently *hyper*diploid and has never been found to be less than the diploid number[16] of 40.

We have shown that it is possible to obtain reliable cytogenetic data from human bone marrow specimens which have been briefly cultured after removal from the body. At present the technical standard is below that attainable with tissues of laboratory mammals, but we hope that others with an interest in the problems we have touched upon will be encouraged to use the method and to improve it.

We wish to acknowledge the skilful technical assistance of Mr. G. Breckon, Miss P. A. Moore, Miss G. P. Smith and Miss S. R. Wakefield.

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RIVER BOARDS IN BRITAIN

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UP to the middle of the twentieth century, the local administration of the rivers of Great Britain was a patchwork of different authorities exercising different functions in completely different ways. There were, for example, in England and Wales, 53 catchment boards administering the Land Drainage Act, 45 fishery boards administering the Fisheries Acts, and more than 1,600 local authorities responsible for the prevention of pollution. For almost one hundred years every commission and committee that considered the subject proposed that all-purpose authorities should be set up to manage single rivers or groups of rivers, and to administer all legislation relating to land drainage, fisheries and the prevention of river pollution. In 1948, these recommendations at last found legislative fulfilment in the River Boards Act. This was "An Act to provide for establishing river boards and for conferring on or transferring to such boards functions relating to land drainage, fisheries and river pollution".

The first river board, that for the basin of the River Severn, was set up early in 1950, and by July 1952 thirty-one other boards had been set up; between them they covered the whole country except the Thames and Lee Catchment Areas (where there were already well-established comprehensive authorities), and the small area within the administrative County of London containing a few streams draining direct to the tidal Thames.

The land-drainage powers of these new boards are embodied in the Land Drainage Act of 1930 and their fishery powers in the Salmon and Freshwater Fisheries Acts of 1923–35; their pollution powers, however, stemmed from an Act passed by Mr. Disraeli's Government in 1876 and experience had shown that this was not well designed for modern conditions. A new Rivers (Prevention of Pollution) Act was therefore passed in 1951 and it gave the river boards much greater powers to deal with the pollution problem. In addition, the boards were given power to obtain either directly or indirectly information about river flows, and for the first time a reasonably comprehensive hydrological survey of England became possible.

In Scotland conditions were rather different. There were no catchment boards; only those rivers containing salmon (and not all of those) were under the control of a statutory fishery authority, and as in England, pollution legislation was administered by local authorities. For various reasons it was decided that comprehensive authorities, like those south of the Border, were inappropriate to Scottish conditions, but the Government decided that the control of river pollution should, as nearly as possible, be put on as effective a basis as it had been in England and Wales. The Rivers (Prevention of Pollution) (Scotland) Act of 1951 therefore enabled river purification boards to be set up to cover the greater part of the country, and gave them, and outside their areas, county councils, powers for the control of pollution approximately equivalent to those exercised by river boards in England and Wales.

All these boards issue annual reports, and these reports are well worth studying by anyone interested in rivers whatever the nature of that interest. They vary somewhat in quality, of course; some are really excellent and some merely competent, but in all of them much of the material is purely factual and is of the utmost value.

My own interests are mainly in fisheries, pollution and water supply, and in these fields the river boards have now been operating long enough to show that they are doing extremely valuable work. Armed with the new pollution powers, they have undoubtedly made great strides in the control of pollution, and that is of great assistance both to fisheries and to those who are seeking suitable water for domestic or industrial use. Progress has, of course, not been as rapid as could have been hoped, but the main brake on progress has been the economic condition of the country and the shortage of the capital required to bring works for the purification of domestic and industrial effluents up to the standards which can readily be achieved by modern techniques. Nevertheless, a great deal has already been done, and it is clear that over the whole of Great Britain progress will continue. Each annual report includes an impressive list of new works installed for the better purification of waste waters, and wherever the effluent from these works discharges to non-tidal streams the river board imposes conditions designed to ensure that the discharge does not cause pollution. It is most encouraging to see how successfully river boards, local authorities and industry have managed to agree on these conditions, and how seldom a dispute has had

to be referred to the Minister of Housing and Local Government for settlement.

In addition, most river boards employ inspectors who see that purification works are properly maintained and operated, and that in itself has greatly reduced the incidence of pollution arising from neglect and carelessness.

Of course, pollution has by no means ceased. In the Midlands, South Lancashire, the West Riding of Yorkshire, and the Forth and Clyde areas, there are many rivers where conditions are still deplorable, where no fish can live, the water is black, brown, grey or even more strikingly coloured, where the consistency may be that of thin mud and the odour likely to be a public nuisance. For the most part, however, these are a legacy of industrial development in the past century, and if only river boards can for the time being ensure that none of them gets worse and some of them a little better, there are considerable hopes for the future. If the outlook for estuaries were as good, those concerned with fisheries might well be optimistic; but at present nearly all estuaries are outside the jurisdiction of river boards for pollution prevention purposes and the continued deterioration of some of them is causing much apprehension.

River boards and river purification boards have in fact come into being at a fortunate time for them. Public opinion is increasingly opposed to the pollution of rivers, and now in the middle of the twentieth century this æsthetic and sentimental approach has been strongly reinforced by the sudden realization that water is a commodity of great value for domestic and industrial use, and that economically we cannot afford that it should be wasted; a badly polluted water is perhaps more effectively wasted than any other.

Of the land-drainage activities of river boards there is no room to write. They arouse mixed feelings, but the work done is necessary to prevent flooding and to increase agricultural production, and many of the technical problems encountered seem to a layman of very great interest.

THE ROYAL BOTANIC GARDENS, KEW

DURING the past decade an open day has been arranged annually in May for students and members of societies interested in botany at the Herbarium and Library, Royal Botanic Gardens, Kew. This year the invitations from the Director were for May 9 or 10 and between five and six hundred attended. Conducted tours around the Gardens enabled visitors to see something of the living collections under expert guidance. The main objects of the open day are to demonstrate some of the work of Kew that is not known to the general public visiting the Gardens, and to help students in their botanical work by showing them as wide a selection as possible of botanical problems and of specially interesting plants and methods of investigating them. With these aims in mind, an extensive special exhibition was prepared by members of the Kew staff in the three wings of the Herbarium and in the Library. The variety of the exhibits, which were excellently staged, documented and demonstrated, could only illustrate a fraction of what is done and what can be seen at Kew; but they did indicate something of the wide field covered by botany.

Systematic botany is a main concern of Kew, and both floristic and monographic researches are in active progress. A Flora of Cyprus is in preparation for the Colonial Office, and maps, specimens and statistics of families composing the flora were exhibited. Large collections at Kew are from Iraq and much preliminary work has been done on them. Recently a complete flora of this country has been planned, and the Iraqi Government and Kew are co-operating in producing it. The desert vegetation, which occurs in part of that country, was illustrated by selected specimens, and its ecological relationships were explained by a map and meteorological tables. The floras of Africa have for many years been given special attention at Kew. Several expeditions to different parts of tropical Africa have been sent from, or in connexion with, Kew since the Second World War. An exhibit showed the equipment needed for a botanical collecting expedition in the tropics and how good botanical collections are made. Three African Floras are now in course of publication for the Colonial Office, for which the work is being done entirely or largely at Kew. The "Flora of West Tropical Africa", second edition, is receiving a very thorough revision. In connexion with this, a recent expedition to Nigeria and the Cameroons was demonstrated by a series of coloured photographs of different types of vegetation. The "Flora Zambesiaca" covers the Rhodesias, Nyasaland and Bechuanaland. The organization of this Flora in collaboration with the British Museum (Natural History), the black-and-white drawings being made for it, and fine photographs of parts of the country were demonstrated. The "Flora of Tropical East Africa" is being published by families, as these are worked out by specialists, mainly at Kew. A sample of the work involved was an exhibit devoted to the genus *Crotalaria*, of which there are 556 species estimated for tropical Africa. An instructive exhibit of selected examples of variation in tropical African plants showed some of the difficulties met with by the systematist and suggested the immense number of problems requiring detailed investigation by cytogeneticists and ecologists in the tropics. Thus, *Alchemilla johnstonii* shows variation that is apparently phenotypic; *Cassia italica* has at least three rather clear geographical subspecies; *Jasminum fluminense* is separated into five subspecies and several varieties; *Commelina africana* is exceedingly variable, but it is uncertain how far the variation is under genetic control; *Acacia goetzei* varies greatly in indumentum and in the number and size of the leaflets, although the characters of the flowers and pods are constant. The range of kinds of vegetation in central Africa, generally, was shown by series of photographs and living plants. A specially interesting exhibit was of representatives of twenty-five families that are mainly tropical but which have one or a few representatives in the British flora. A somewhat similar series of plants, but at the species-level,

showed links between the floras of Britain and tropical East Africa. All but one of the twenty-four exhibited, and others are known, are presumed to be natives of the two areas. In East Africa many of them are in high mountain habitats. The introduced exception was *Galinsoga parviflora*, a weed of American origin.

A series of British plants of special interest was subdivided as follows: species that have become extinct in Britain within living memory (such as *Schoenus ferrugineus*, *Spiranthes aestivalis* and *Orobanche ramosa*); species that have been recorded in Britain, but of which the records have not been confirmed (as *Rubus arcticus*, *Silene rupestris* and *Limodorum abortivum*); British plants formerly abundant but now on the verge of extinction (*Cypripedium calceolus*, *Potentilla rupestris* and *Orchis militaris*); plants formerly of a reasonably wide range but now extinct in Britain (*Senecio paludosus*, *Senecio paluster*); introduced or native plants formerly common or locally common but now very rare (such as *Caucalis lappula*, *Roemeria hybrida* and *Stachys germanica*); species, mostly more or less recent introductions, now increasing in the British flora (a large number shown, including *Sisymbrium orientale*, *Juncus tenuis*, *Veronica filiformis*, *Quercus cerris* and *Senecio squalidus*). The main British groups of *Salicornia* were illustrated by specimens and photographs, including living seedlings from seeds sown on April 18 which germinated ten days later.

Monographic revisions were demonstrated for *Camellia*, for which genus a monograph is in the press, for *Hypericum*, with diagrams, specimens and maps arranged to show trends in the evolution of the genus, for the grass genus *Eleusine*, and for the genus *Dianthus*.

The cryptogams were exemplified by specimens and photographs showing the characters of the venation in species of *Polypodium*, by a considerable number of living plants of tropical African ferns indicating their wide range in size and vegetative morphology, by specimens selected to show the growth forms found in tropical fungi, and by photographs, drawings and specimens of the bog mosses (*Sphagnum*).

Botanical researches have often to be illustrated by paintings, drawings, photographs or diagrams, and these are continually being prepared at Kew. Original paintings for the *Botanical Magazine*, a journal commenced in 1787 and edited at Kew from 1841 to the present day (since 1922 for the Royal Horticultural Society), black-and-white originals for "Drawings of British Plants" by Miss Ross-Craig, paintings of lilies by Miss L. Snelling, and a large series of sketches, etc., by working botanists, often not for publication, demonstrated the range of botanical illustrations. The essence of the last-mentioned illustrations is that they shall convey information concisely and without the possibility of misconception, and they need not be 'works of art', though some are.

The varied work carried out at Kew in connexion with economic plant products was illustrated by the varieties of guinea corn or great millet (*Sorghum*) from tropical Africa, by an interesting exhibit of vegetable waxes and plants yielding them, and by a demonstration of plant introduction. The cultivation of cinchona (for quinine) and of rubber in the Asiatic tropics was largely due to Kew. At the present time, disease-resistant varieties of bananas, cocoa and other tropical crops are being grown and partly tested under quarantine conditions at Kew before being introduced into new areas.

Several exhibits were of a miscellaneous nature. One that attracted considerable attention was of early dissecting and compound microscopes contrasted with some of the latest models. A fine series of living specimens of nearly all the existing genera of conifers occupied one end of the newest wing of the Herbarium. From the Jodrell Laboratory, specimens and microscopic preparations demonstrated the methods of dealing with archæological material of plant origin for determination. Photographs and diagrams illustrated work in progress on certain tropical plants by irradiation by mercury-vapour lamps. Germination and flowering were affected and there was increased growth shown and most plants improved in general health and vigour. In *Aristida*, a widespread grass genus in subtropical and tropical countries, with about 400 species, especially in the drier parts of Africa, Australia and America, the awn aids in dispersal. A series of specially prepared specimens showed the gradual increase in size of the awn and various developments in its structure. Living specimens of *Arundinaria fastuosa* grown at Kew illustrated the periodic flowering of bamboos.

For students from schools and colleges there were a number of well-devised exhibits. These included: the various methods of dispersal shown in the Gramineæ, with water, wind or animals acting as agents; living and dried specimens and drawings and pictures of the evolution of leaves; a comprehensive collection of living succulent plants of such diverse families as Cactaceae, Euphorbiaceae, Asclepiadaceae, Liliaceae, Apocynaceae, Compositae, Portulacaceae, Crassulaceae and Vitaceae; a large number of 'plants of special interest to students', including living examples of phyllodes, phylloclades, cauliflory, phylloflory, hybrids, unusual organs of attraction, kinds of armature, and vegetative multiplication; the switch habit in Australian plants, as correlated with relatively low rainfall and a sunny climate, and shown in twenty-four different families; and phenomena of plants in the tropical American rain forest, including epiphytes, parasites, saprophytes, epiphyllous liverworts, lianes, climbers, myrmecophytes, drip-tips, and so on.

One of the important works prepared at Kew is the "Index Kewensis", and the method of compilation was demonstrated. The "Index Kewensis" was initiated by Charles Darwin and the original volumes contained names of seed-bearing plants published from 1753 until 1885. Supplement 12 (1951–55) is now in the press. Darwin had close connexions with Kew, especially through personal friendship with Sir Joseph Hooker. An exhibit of historical interest included some of his letters, specimens collected by him, and some of his books.

The Library was open to visitors, and there were arranged special exhibits of books from the library of Dr. Bromfield which formed the nucleus of the Kew Library (now having more than 55,000 volumes); old woodcut herbals; British county floras; botanical works and periodicals prepared at Kew; botanical bibliographies; botanical publications illustrated in colour; Colonial floras; a selection of books presented by the Bentham-Moxon trustees; manuscripts and original letters from the Hooker correspondence (of which seventy-six volumes are at Kew), from Boott, D. Don, R. Spruce, and other well-known botanists, and samples of Bentham's diary which he kept for more than seventy years.

W. B. Turrill

BRITISH ASSOCIATION INQUIRY INTO THE METRIC SYSTEM

TO the young scientist making contact with industry or commerce fresh from school or university it comes as rather a shock to find that his general 'scientific' usage of the C.G.S. system has such small acceptance in the outside 'practical' world. True, he has used 'Winchester quarts' to hold his standard solutions made up in grams per litre, he has stirred with fractional h.p. motors and dabbled in foot-poundals and lb./sq. in. But he has learned to think in metric units and centigrade degrees. He knows that engineers seem to be able to exist with other units, and he respects their attempts to decimalize the rather antique units that he finds them using. He will probably be surprised to learn that Great Britain narrowly missed adopting the metric system of weights and measures almost one hundred years ago by a handful of votes in Parliament. Since then, the question has been the subject of heated discussion on many occasions. The most recent general investigation appears in Part 1 of the Hodgson Report produced in May 1951 by the Committee set up under Sir Edward Hodgson by the Board of Trade. This made the following recommendations.

That the Imperial system should eventually be abolished in favour of the metric, and that the change should be preceded by : (*a*) discussion with industry and commerce to determine the period of transition ; (*b*) agreement with the Commonwealth and the United States for a simultaneous change on their parts ; (*c*) a lengthy process of preparing the general public for the change ; (*d*) decimalization of the coinage ; (*e*) preparation of schemes for the compulsory change-over, trade by trade, during the period of transition, with provision for compensation wherever necessary.

The Hodgson Committee did not attempt to assess the cost to the country of a general adoption of the metric system, and from time to time one sees statements quoting very large figures indeed as the 'cost' of the change-over. Even in the short period since 1951 the international situation and the climate of opinion have been changing, and we have seen the increasing emphasis on pan-Europeanism and we have recently seen the official adoption of the metric system by India.

One of the main objects of the inquiry now instituted under the auspices of the British Association for the Advancement of Science is to make a statistical estimate of the short-term cost and the long-term profit to Great Britain of a change-over to the metric system, rather than to assess current opinion on the matter. In short, to find out whether we cannot afford to make the change or whether we cannot afford not to make the change. To this end it is proposed to approach a cross-section of British industry with the co-operation of the Federation of British Industries and the various trade associations. It is hoped that a factual appraisal will help to form opinion and that these basic facts will be of assistance to those who have to make the decision. Certainly, without facts the subject will remain largely a means of arousing passion.

There is one by no means unimportant aspect of the question on which action could well be taken irrespective of a general change-over in industry and commerce. This is the question of school education. It seems that in any event the people of Britain will have to live with two systems side by side for many years and that at present there is too little attention given to proficiency in the metric system among non-scientific students ; and together with this goes the question of rationalization of the existing Imperial system, some elements of which could surely be eliminated forthwith.

The British Association Committee which is to study this question is under the chairmanship of Sir Hugh Beaver and is composed of Dr. A. H. Hughes, deputy chairman (assistant managing director of Arthur Guinness, Son and Co., Ltd.), Dr. R. Beeching (director of Imperial Chemical Industries, Ltd.), Mr. M. G. Bennett (general treasurer, British Association), Prof. C. F. Carter (professor of applied economics, Queen's University of Belfast), Mr. Hugh Conway (joint managing director, Short Brothers and Harland, Ltd.), Mr. A. C. Hartley (consulting engineer), Mr. F. S. Walker (chairman of Lever Brothers, Port Sunlight, Ltd.) and Mr. C. P. Jones (Rolls-Royce, Ltd.).

NEWS and VIEWS

Royal Society of Edinburgh : David Anderson-Berry Prize

THE Royal Society of Edinburgh has made two awards of the David Anderson-Berry Prize for 1958 : to Mr. W. M. Court Brown, director, Medical Research Council Group for Research on the General Effects of Radiation, Western General Hospital, Edinburgh, and Dr. Richard Doll, Medical Research Council Statistical Research Unit, London School of Hygiene and Tropical Medicine, London, for their work on the incidence of leukæmia after exposure to radiation ; and to Dr. C. E. Ford, Medical Research Council Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, for his work on the survival of transplanted marrow cells after exposure of the recipient to radiation, so making an important extension of the field of radiotherapy. Each recipient will receive a cash award together with a David Anderson-Berry Silver-Gilt Medal.

Soddy Commemoration Plaques

AT a dinner to scientists and politicians given by Lord Grantchester in the House of Lords on May 16, three plaques were shown which are to be set up in commemoration of the late Prof. Frederick Soddy, first British Nobel laureate in chemistry. Mr. T. E. Rodd, science master of Eastbourne College, was presented with one in bronze and white enamel. This is to be installed in one of the new laboratories of the College, which is to be called the Frederick Soddy

Memorial Laboratory. Prof. W. H. Davies, of the University of Wales, was presented with a plaque for the laboratories at Aberystwyth, from which Soddy gained a scholarship to Merton College, Oxford. A larger plaque, commemorating the work done by Soddy in collaboration with Rutherford during 1900–3, which led to the discovery of transmutation, interpreted by Soddy as the disintegration of the atom, was on show and will be sent to McGill University to be set up in the chemistry laboratory.

Organization for European Economic Co-operation: Office of Scientific and Technical Man-power

A special Office of Scientific and Technical Man-power has been set up within the Organization for European Economic Co-operation to direct its drive for increasing the supply of qualified scientists and engineers needed to meet the growing demand of the industries of Europe. Dr. Alexander King, while continuing as deputy director of the European Productivity Agency, has been appointed director of the new Office, responsible to the Secretary-General of the Organization for European Economic Co-operation. The scientific man-power programme will be under the direction of a governing committee composed of representatives of seventeen European States, the United States and Canada. The Organization has already initiated several projects in this field which will now come under the direction of the new Office. These include an annual review of the policies and programmes of member countries for the training of scientists and engineers; a study of techniques for forecasting demand for scientific and technical personnel and a series of summer training courses for science and mathematics teachers. Funds for this programme and other projects will come from an allocation of 500,000 dollars by the United States Government, together with an initial contribution by the member countries of the Organization and special additional contributions as further projects are approved by the governing committee.

New Nature Reserves

Rusland Moss is one of the few remaining examples in the southern Lake District of a 'moss' which has not been damaged beyond repair. It is a raised bog only 20 ft. above sea-level which originated in a lake. Although partly cut and drained, it still retains most of the characteristic bog plants and animals. The reserve, which has been established under a Nature Reserve agreement with the owner, Judge Myles Archibald, covers 30 acres. The Moss is about 4 miles north of Roudsea Wood Nature Reserve, Lancashire, and is conveniently near the Nature Conservancy's main research station at Grange-over-Sands. Permits, which will be necessary for those wishing to visit or collect specimens of animals or plants, can be obtained from the Regional Officer for the North, The Nature Conservancy, Merlewood Research Station, Grange-over-Sands, Lancashire.

In June 1957 the Nature Conservancy established the Rodney Stoke Nature Reserve, a small ash wood on the Mendip Hills near Cheddar in Somerset. Two small further areas have now been added, bringing in the smaller western wood and some scrubland, thus completing the reserve, which now covers an area of 86 acres. The western wood contains an outcrop of Carboniferous limestone, and there are interesting differences in the flowering plants on the south-western and north-eastern sides of this outcrop. Applications for permits to visit the reserve and for authority to undertake research and to collect specimens of animals and plants should be sent to the Regional Officer for the South West, The Nature Conservancy, Furzebrook Research Station, Wareham, Dorset.

Industrial Smoke

There was a debate in the House of Commons on May 13 and 14 on a motion of Mr. G. Nabarro's, seconded by Sir Charles Taylor, praying for the annulment of the Alkali, etc., Works Order, 1958, which seeks to transfer from the local authorities to the Alkali Inspectorate the responsibility for discharges from industrial chimneys in certain industries. The Minister of Housing and Local Government, Mr. H. Brooke, said that the Order was a statutory instrument made under the Public Health (Smoke Abatement) Act, 1926, the first to be made since the extension to smoke, grit and dust was approved in the Clean Air Act, 1956. It arose out of a specific recommendation of the Beaver Committee, and was not intended to give the industries specific protection from any action taken by authorities but to enable certain special technical difficulties to be tackled by a single inspectorate with special technical qualifications, reviewing each industry as a whole. The trouble was due not to unskilled or careless operation but to the fact that scientific research had not yet solved the problem of operating the particular plant without risk of producing dark smoke. The Order would apply to about 2,000 works out of a total of 25,000–30,000 throughout Britain, and does not deprive local authorities of powers which they have hitherto effectively possessed. He assured the House that he would use his powers so that the Alkali Inspectorate had every opportunity of stimulating the necessary scientific research, and wherever a local authority is well qualified to take over the work an Order will be made to enable it to do so. So long as he was Minister, the relevant Section 17 (2) of the Clean Air Act would not be treated as a dead letter and he intended to treat any such application on its own merits. Mr. Brooke was satisfied as to the effectiveness of the Alkali Inspectorate and in view of his explanation and assurance the motion was withdrawn.

The Opticians Bill

The Opticians Bill, which received an unopposed second reading in the House of Lords on May 12, has the support of all ophthalmic practitioners, and although not a Government Bill, was commended to the House by the Minister of State, Scottish Office, Lord Strathclyde, who said that the Government is satisfied that the Bill is in the general interest of the health and well-being of the people, while safeguarding the right of practitioners affected by it and maintaining and raising professional standards. In moving the second reading, Lord Amherst of Hackney explained that the Bill followed closely the recommendations of the interdepartmental committee set up in 1949 under Lord Crook's chairmanship. It would set up a General Optical Council to promote high standards of professional education and conduct, charged with the establishment of the three registers: two of ophthalmic opticians and one of dispensing opticians. The first register would comprise those who merely test sight; the second those who test and dispense glasses; and the third of dispensing opticians. Lord Crook, in supporting the Bill, explained some of the ways in which existing abuses

would be removed and the public protected. In future, no one who has not had a thorough training may dispense or prescribe spectacles, but the Bill will not prevent, for example, a nurse testing the sight of school-children to ascertain whether they should go to an optician or an oculist, or testing a person's sight to ascertain whether he or she is suitable to carry out a particular task in industry.

Spanish Electronics Bulletin

THE recent development of the electronics industry in Spain is indicated by the publication of the first issue of the *Boletín de información Electronica* (1, No. 1; 1958. Pp. 62. Madrid: Instituto Nacional de Electronica, 1958. 25 pesetas). The contents are in Spanish and consist of two main articles; two technical contributions on the microwave band and an alarm and warning system for civil defence; a glossary and explanation of electronic terms, including klystron, spin, bias and radar; notes on new materials, instruments and circuits; and classified abstracts of articles in electronics journals. The two main articles are devoted to an introduction to the theory of information by A. Colino, director-general of Marconi Espanola, and to a description of the work and function of the Instituto Nacional de Electronica, respectively.

Microtexts and Microrecording

THE proceedings at a symposium held at Hatfield Technical College on January 14 have recently been published ("Microtexts and Microrecording"; pp. 27 + 16 figures. County Technical Librarian, Hatfield Technical College, 1958. 4*s*.). They include a survey of microtexts by H. R. Verry; the commercial use of microfilm by A. J. Brockbank; and handling, filing and indexing microtexts by Miss M. D. Gauntlett. A preface by the chairman, Councillor T. G. Mercer, explains that the symposium was arranged by the advisory committee appointed early in 1957 to assist in the establishment of a county technical library service, in which the Hertfordshire Special Libraries Group is actively co-operating. The advisory committee has recommended the installation of a microrecording unit at Hatfield Technical College as part of the proposed technical library service, which should be available to industry. Any firm interested in the possible application of microrecording or in the proposed technical library and information service is invited to approach Mr. G. H. Wright, the county technical librarian, at Hatfield Technical College. The value of Mr. Verry's survey and of Mr. Brockbank's account of the commercial use of microfilm is enhanced by the illustrations of readers and viewers and other equipment included in this report.

Population Statistics for England and Wales

THE Civil Tables of the Registrar General's Statistical Review for England and Wales for 1956 which have just been published (The Registrar General's Statistical Review of England and Wales for the year 1956. Part 2: Tables, Civil. Pp. x + 180. London: H.M. Stationery Office, 1957. 7*s*. 6*d*. net) are in the main similar to previous issues. There is, however, one important addition to the fertility analysis. New tabulations make it possible to trace the fertility experience of a cohort of married women by exact duration of marriage, as well as the total exposure to risk in 1956. It has always been one of the difficulties in the analysis of fertility that it was not possible from the official statistics to relate the duration of specific fertility experience to the calendar year of marriage. Thus, women married between two and three years in 1956 may have been married either in 1953 or in 1954, and before this year it was impossible to allocate births in these years to the appropriate marriage cohort The new tabulation (Tables *NN* to *PP*) makes such an allocation possible and thus enables the computations of the Royal Commission on Population on mean family size by exact duration of marriage to be continued. The new tabulations will be generally welcomed by demographers who are anxious to apply the techniques of cohort analysis to England and Wales.

Industry and the Technical Colleges

A REPORT of the regional conference on industry and the technical colleges, organized by the Southern Regional Council of the Federation of British Industries, in co-operation with the Southern Regional Council for Further Education and held at Windsor on October 15, has been published by the Federation (pp. 46. London: Federation of British Industries, 1958. 2*s*.). It includes the addresses of Mr. A. A. Part, Under-Secretary, Ministry of Education, on the background to the present position in technical education, and of Mr. H. A. Collinson, managing director, Leicester, Lovell and Co., Ltd., on the needs of industry in technical education. There are also accounts of the ensuing discussions, including a panel discussion on industry's part in the administration of technical colleges, and Sir Henry Tizard's speech in summing up the conference; some figures illustrating the background to technical education are appended. Sir Henry did not attempt to sum up the discussion regarding the constitution of governing bodies of technical colleges, in which strong views were expressed as to the importance of effective industrial participation in the administration of such institutions. He stressed the need to raise the prestige of the technical colleges so that they attract more of our ablest and most intelligent young men, who at present enter the financial world instead of the technical side of industry. Mr. Collinson emphasized the need for better liaison between the technical colleges and the grammar schools, for more co-operation between industry and the technical colleges and for more attention to management studies: industry needs trained men at all levels but, above all, men with pass degrees and professional qualifications to form the hard core of practical management teams to secure the effective execution and application of production, development and research.

Imperial College of Science and Technology

THE fiftieth annual report of the Governing Body of the Imperial College of Science and Technology (Imperial College of Science and Technology (University of London). Fiftieth Annual Report, Jubilee Year 1956–1957. Pp. 91. London: Imperial College of Science and Technology, 1958) covers the year ended July 31, 1957. It includes Sir John Cockcroft's commemoration day address; the address of welcome to Queen Elizabeth the Queen Mother at the formal opening of the new Roderic Hill Building for Aeronautics and Chemical Engineering on May 28; Lord Hailsham's speech at the Mansion House on May 27, and the Rector's reply; the usual departmental lists of publications; and a list of special

lectures during the year. Full-time students increased by 142 to 2,215, of whom 700 were postgraduate; 830 were students of science and 1,385 of technology. In addition, there were 134 research assistants and 357 part-time students. The total number of degrees and diplomas awarded was 1,320, an increase of 279 on 1955–56. The teaching staff at the end of 1956–57 was 353, an increase of 31, the number of professors of the University increasing from 32 to 33 and of readers from 49 to 55. Of the 9 students who entered the first preliminary year course for students who had not specialized in science at school, 8 passed the 'Intermediate' examination at the end of the year and proceeded to normal first-year courses. For the first full year postgraduate course to begin in October 1957, 24 students have been selected. Russian classes at both elementary and advanced level were introduced for the first time in 1956–57 and a further exchange studentship has been arranged with the Technical University of Berlin, Charlottenburg. Considerable advances were made in planning new buildings and the "*E*" building to house mechanical engineering and the common engineering course was started. Students in residence totalled 131, but the growth of the College in recent years has been so great that the proportion in residence has fallen below 8 per cent; however, erection of the new Weeks Hall is expected to be complete in two years time, and it will house about 75 students.

Organization of Conferences

The Council for International Organizations of Medical Sciences has issued simultaneously in English and in French a handbook on "The Planning of International Meetings", which summarizes experience gathered by the Council and by the World Federation for Mental Health (pp. v+113. Oxford: Blackwell Scientific Publications, 1957. 7*s*. 6*d*.). It also takes into account the information presented at a conference on the effective functioning of discussion groups and small conferences. After reviewing some preliminary considerations, such as the aims of the organizers and participants and their bearing on the type of conference, the handbook surveys in successive parts the organization of large international congresses (300–3,000); smaller conferences (100–300); discussion groups (10–12); international symposia and seminars (of up to 50 people and lasting one to three weeks); and international committees. The emphasis is practical, with the view of eliminating overlapping and competition, securing the most efficient means of organization and the saving of time of trained man-power, and attention is directed to the way in which operational research, for example, might improve communications.

National Research Council of Canada

The Review of the National Research Council of Canada, 1957 (N.R.C. No. 4371. Pp. 289+14 plates. Ottawa: Queen's Printer, 1957. 75 cents), covers the work of the Council during the year ended December 31, 1956, but includes some later work. Supplementing the annual report already issued, it contains reports of the directors of Divisions and heads of Sections, accounts of work of the Council's committees and details of grants to university research workers. With a roster of scientific staff, associate committees and lists of publications, it is a comprehensive reference work on the activities of the Council.

Durban Museum and Art Gallery

The annual report of the Durban Museum and Art Gallery for 1956–57 reports that the major activity was the completion of the William A. Campbell Hall of South African Mammals. Also during the year steps were taken towards providing a new hall devoted to marine life. A number of experiments have been conducted with different media for making replicas of the various forms of life required. Synthetic resins have been used with some success. Systematic research on the birds of Africa has been carried out by Mr. P. A. Clancey, director, and *Durban Museum Novitates* has been issued on three occasions.

Internal Migration

Population movements, as shown by entries in the National Register between 1947 and 1951, were discussed in Paper No. 5 of the series of Studies on Medical and Population Subjects issued by the General Register Office; no information about the number of individuals who moved was presented then. A more recent study (General Register Office. Studies on Medical and Population Subjects, No. 11: Internal Migration—a Study of the Frequency of Movement of Migrants. By John A. Rowntree. Pp. ii+11. (London: H.M. Stationery Office, 1957.) 1*s*. 3*d*. net), sampling the same data for the years 1948–50, shows that about 13 per cent of the population moved in those years: movement in this sense excludes changes of address within a town or county area. Every migrant made on the average 1·6 moves or, to put it another way, every eight moves in the Register represent five different persons moving. Second moves for migrants who moved more than once took place within six months for 43 per cent of them and within one year for 70 per cent. Age, rather than marriage, appears to be the important factor in migration: most movements are by young adults, aged 15–29, probably in search of a job. Regional differences are marked, showing that a lot of this migration is over long distances and not simply to the suburbs of the great cities. More moves per migrant occurred in Northern, Southern and Midland Regions, and in Wales than in the rest of England and Wales. This paper is a beautiful example of demographic description. It confirms assumptions made in the earlier paper about the age, sex, and marital characteristics of migrants. Surely, in view of the practical value of information about internal movements of population for housing and education, an effort should be made to frame a question on migration for the 1961 Census.

Australian Malacology

The study of malacology in Australia may be considered to have commenced when *Endeavour*, commanded by Captain Cook, anchored in Botany Bay, New South Wales, and Dr. Solander collected on its shores in 1770. Since that time a number of malacologists both from outside in the early days and, more recently, from within the continent, have studied its molluscs. While much still remains to be discovered, sufficient is known to indicate that it has one of the richest molluscan faunas in the world. Most of the States have enthusiastic clubs or groups, but it was not until the end of 1956 that the Malacological Society of Australia had its first meeting in Melbourne. In September of the following year the membership was more than 100, and No. 1

of the Journal of the Society appeared (*Journal of the Malacological Society of Australia*, No. 1, September 1957. Pp. 52. 15*s*.). This consists of 52 pages almost identical in size with those of the *Proceedings of the Malacological Society*, six of them utilized as plates. It contains eleven articles, of which the longest two deal with opisthobranchs, and the author of the second, Robert Burn, has set an example which it is hoped will be followed by subsequent writers, of presenting type specimens to a national museum. One of the patrons of the Society is Prof. R. Tucker Abbott of the Academy of Natural Sciences, Philadelphia, a very fitting selection in view of the old association between the Academy and Australian malacologists. The paper, printing and general format of the journal are very good and it is a praiseworthy start. We should like to wish the Society and its journal every success. No. 1 is priced 15*s*. but there is no indication of how frequently it will appear or of the steps necessary to become a member of the Society. Doubtless these details can be obtained from the Secretary, 351 Glenferrie Road, Malvern, Melbourne, Australia.

Reptile Faunules

Investigations by Donald Baird in quarries in the Delaware valley near Milford, New Jersey, have yielded three faunules of reptile footprints at three horizons of the upper Brunswick formation (Newark series, Upper Triassic). Each determinable species was analysed by comparison of outlines printed from latex moulds of all adequately preserved specimens (Bulletin of the Museum of Comparative Zoology at Harvard College, 117, No. 5; 1957). Body proportions and locomotor habits were deduced from trackways and the pedal skeletons were reconstructed from the arrangements of articular swellings in the footprints. Comparison with other Triassic footprints furnished information on faunal distribution and stratigraphic correlation; comparison of the restored skeletons with those of Triassic reptiles served to elucidate and enlarge the known Brunswick fauna.

Plankton and the Herring Fisheries

The pioneer investigations of Sir Alister Hardy into the relation between herrings and the plankton that forms their food have been continued by Mr. R. S. Glover and his colleagues of the Edinburgh Oceanographic Laboratory. The improved plankton 'indicator', which takes samples from ships at speeds up to 8½ knots, is now a simple and elegant instrument for detailed surveys, as two recent publications demonstrate. Results of nine years sampling, by fishing boats and research vessels, over the summer fishing grounds off the north-east coast of Scotland are described by Mr. Glover (Bulletins of Marine Ecology (formerly Hull Bulletins of Marine Ecology), 5 (39); December 1957. The Planktonic Environment of the Herring. By R. S. Glover. Pp. 1–43+plates 1–8. Edinburgh: Scottish Marine Biological Association, 1957. 13*s*.). The spatial and temporal distribution of the commoner organisms taken by the indicators are shown by means of contoured charts, and commented on. It is suggested that changes in the plankton during 1951–54—a predominance of more or less oceanic species—were related to changes in the volume and direction of flow of Atlantic water entering the North Sea. Accompanying changes in the fishery, in particular the occurrence of increased catches on the southern grounds and a failure of the Shetland fishery, appear to have been related to the plankton changes. However, Mr. Glover points out that non-feeding fish are caught during the second half of the season (July and August), and more subtle environmental factors than food may therefore have influenced the shoaling of the fish. A study of the plankton in the area of the autumn fishery off the south-west coast of Iceland by Herr J. Jakobsson (Rit Fiskideildar, 2 (5): A Study of the Plankton–Herring Relationship. By Jakob Jakobsson. Pp. 26. Reykjavik: Atvinnudeild Háskolans: Fiskideild, 1958) shows that this fishery conforms with other feeding fisheries in that shoals aggregate in areas rich in zooplankton, chiefly the copepod *Calanus* and euphausids. Correlation between echo-sounder traces of herring and concentrations of euphausids was obtained only with the plankton indicator, few euphausids being caught by means of a vertical Hensen tow-net. This emphasizes the superiority of high-speed samplers for the purpose.

Complementary Action of Gibberellic Acid and Auxin

Although gibberellic acid has certain auxin-like activities, it differs from auxin in many respects. P. W. Brian and H. G. Hemming (*Annals of Botany*, N.S., 22, 1; 1958) have now shown that gibberellic acid induced extension of green pea-stem sections in light only if an auxin was also present. Of the auxins tested 3-indolylacetic acid, 2-methyl-4-chlorophenoxyacetic acid, 2:4-dichloro-phenoxyacetic acid and 1-naphthylacetic acid were effective in increasing extension of sections and in eliciting a response to the acid. Excised internodes from plants pre-treated with gibberellic acid extended appreciably faster *in vitro* than those from untreated plants only if an auxin was supplied in the incubation medium. This and other evidence suggests that in the intact plant gibberellic acid elicits a growth-response only in the presence of auxin. By comparing growth-rates of excised internodes *in vitro* and of intact internodes *in vivo* under comparable conditions, using untreated plants and plants pre-treated with gibberellic acid, evidence has been obtained that in untreated plants growth-rate is somehow limited to a level below that made potentially possible by the endogenous auxin supply; treatment with gibberellic acid appears to release the plant from this state of inhibition. Growth of intact pea internodes is considered to be regulated by a three-factor system, consisting of auxin, an inhibitory system, and a hormone with physiological properties similar to those of gibberellic acid.

Diffusion in the Atmosphere

It is remarkable, considering the fundamental nature of the problem, that no discussion of the dynamics of plumes formed by natural convection from point and line sources of heat appeared before 1941, when W. Schmidt produced his now well-known 'mixing length' treatment. In recent years the problem has attracted much attention because of its importance in connexion with atmospheric pollution. The greater part of a recent monograph (Koninklijk Nederlands Meteorologisch Instituut, De Bilt. Mededelingen en Verhandelingen. Nr. 68: On the Diffusion of Stack Gases in the Atmosphere. By F. H. Schmidt. Pp. 60. 'S-Gravenhage: Staatsdrukkerij- en Uitgeverijbedrijf, 1957. 5 florins) is concerned with a discussion of the solutions derived by W. Schmidt, Sutton, Priestley and Ball, Morton, Taylor and Turner and by the author. Considerable

attention is also given to the few laboratory measurements that have been published, but this part of the text needs to be read with caution. The author has misunderstood, for example, Railston's use of the schlieren optical system in his investigation, and the rejection of Railston's results is not justified. The monograph is likely to prove useful to anyone who wishes to pursue this difficult but attractive subject further, and Dr. Schmidt's treatment, although not leading to strikingly novel results, has the merit of being derived from the equations of hydrodynamics without making use of mixing-length concepts directly. There is also a fairly complete bibliography.

Institute of Information Scientists

At a meeting of the Institute of Information Scientists, held on May 23, the main clauses of a constitution for the Institute were approved, and officers and a council were elected as follows: *President*, Dr. G. Malcolm Dyson; *Vice-President*, C. W. Hanson; *Honorary Secretary*, J. Farradane; *Treasurer*, A. Gordon Foster; *Council*, Miss D. Caldwell, Miss I. M. Slade and Messrs. L. J. Haylor, A. H. Holloway, F. Liebesny, J. S. P. Paton, J. B. Reed and O. W. Snow. The Council will proceed to consider applications for membership, the registration of the Institute as a limited company under Board of Trade regulations, preliminary steps towards the provision of examinations for the certificate of the Institute, the promotion of educational courses, and the arrangement of suitable meetings. The aims of the Institute are to act as a professional qualifying body for those engaged in scientific, technical and economics information work, and to promote and maintain high standards in such work. Further details can be obtained from Mr. J. Farradane, "Torran", Crofton Road, Orpington, Kent.

Institution of Metallurgists: Officers

At the annual general meeting of the Institution of Metallurgists on May 20, Mr. W. E. Ballard, managing director of Metallization, Ltd., was elected president of the Institution in succession to Mr. J. Mitchell. The following were also elected to office: *President-elect*, Prof. A. J. Murphy, principal of the College of Aeronautics, Cranfield; *Vice-Presidents*, Dr. N. P. Allen, superintendent of Metallurgical Division, National Physical Laboratory, and Mr. G. Meikle, Royal Aircraft Establishment, Farnborough; *Hon. Treasurer*, Dr. E. G. West, technical director, Aluminium Development Association; *Members of Council*, Prof. J. G. Ball, Imperial College of Science and Technology, Mr. N. I. Bond-Williams, managing director, Aston Chain and Hook Co., Ltd., Prof. G. V. Raynor, University of Birmingham, and Mr. V. S. Kingwood, Battersea College of Technology.

University News: Leeds

Dr. R. E. Dickinson has been appointed professor of geography in the University of Leeds from a date to be arranged, and the title of reader of applied mathematics has been conferred upon Dr. N. B. Slater, senior lecturer in applied mathematics.

The University has received a gift of £50,000 under deed towards the fund for new buildings, from Messrs. R. W. Crabtree and Sons, Ltd. The University has signified its intention of giving the name 'R. W. Crabtree Lecture Hall' to a large lecture theatre which is to be included in the new engineering building, costing £1½ million, construction of which started this year.

Liverpool

Dr. J. H. Horlock, lecturer in engineering in the University of Cambridge, has been appointed to the Harrison chair of mechanical engineering in the University of Liverpool, in succession to Prof. W. J. Kearton, who is retiring. Dr. T. Wilson has been appointed senior lecturer in tropical hygiene.

Sheffield

The following appointments have recently been made in the University of Sheffield: P. F. Harris and M. Taylor, to be lecturers in anatomy; Miss E. L. Jervis, to be lecturer in physiology; and Dr. D. Hobson, to be honorary lecturer in bacteriology.

Announcements

Vice-Admiral Sir Frank Mason, director of Metal Industries, Ltd., and H. W. Kearns and Co., Ltd., has been appointed to succeed Sir Andrew McCance as chairman of the Mechanical Engineering Research Board of the Department of Scientific and Industrial Research.

Mr. R. G. Friend has been appointed director of electronics research and development (telecommunications) in the Ministry of Supply in succession to Brigadier J. D. Haigh.

The International Association for Cybernetics is organizing the Second International Congress on Cybernetics in Namur, Belgium, during September 3–10. Further information can be obtained from the Secretariat, Association Internationale de Cybernetique, 13 rue Basse-Marcelle, Namur.

The Combustion Institute's seventh International Symposium on Combustion will be held at the Royal Institution, London, and at the University of Oxford during August 28–September 3. Further information can be obtained from the Chairman, Combustion Institute Committee, c/o Institute of Fuel, 18 Devonshire Street, Portland Place, London, W.1.

A conference on the "Chemical Organization of Cells, Normal and Abnormal" will be held in Madison, Wisconsin, during August 21–23. Participants will be authorities on anatomy, biochemistry, embryology and pathology, who will correlate recent information about the cell in a series of formal presentations. Further information can be obtained from Prof. Joseph J. Lalich, University of Wisconsin, Madison 6, Wisconsin.

The fourth International Biometric Conference will be held in Ottawa during August 28–September 2. One day will be devoted to a symposium on biometrical genetics, and sessions are being arranged on clinical research, the interpretation of experimental results, applications of multivariate analysis, ecology and animal behaviour, mathematical models in biology, the χ^2 test, and plant and animal breeding. Further information can be obtained from the Local Secretary, Dr. G. B. Oakland, Statistical Laboratory, Science Service Building, Department of Agriculture, Ottawa.

The Arnold Gerstenberg Studentship for 1959 is open to members of the University of Cambridge who, going into residence not earlier than 1953, have obtained honours in the Natural Sciences Tripos and who wish to pursue a course of philosophical study. The Studentship will be awarded for an essay, which must be submitted before May 1, 1959. Further information can be obtained from Prof. R. B. Braithwaite, King's College, Cambridge.

BRITTLE MATERIALS

THE mechanical properties of brittle materials, whether artificial, as glass, ceramics or concrete, or natural, as coal or rock, are less well known and understood than are those of ductile materials. The difficulty lies, in part, in the wide random variations in strength frequently observed in the same substance. This stems from the lack of ductility which renders brittle materials unable to accommodate local stress concentrations in the vicinity of chance cracks or flaws, which therefore precipitate breakage. In some cases inhomogeneity and anisotropy are obvious additional complications. None the less, the mechanical properties and particularly the strength of such materials are of immense technical importance, whether they are required to withstand loads or to be broken. Some materials, such as brick and concrete, have been studied extensively, and standard tests and specifications evolved, but there is little basic knowledge of the relationship between properties and structure. For many other materials, test methods have scarcely evolved beyond simulated user trials of finished articles. While much remains to be learnt about traditional materials, modern technology is pressing for information on new substances and on behaviour under extreme conditions of temperature, pressure or atomic bombardment.

In view of this lack of fundamental knowledge in relation to coals and rocks, the National Coal Board is undertaking at its Mining Research Establishment, Isleworth, Middlesex, a programme of research which, it is hoped, will lead to a system of classifying these materials according to their technically significant properties, and aid the development of improved mining techniques. In the course of this work it seemed that a mutual exchange of information on theories and techniques in various fields would be useful. The Mining Research Establishment, in consultation with the Building Research Station of the Department of Scientific and Industrial Research, therefore organized a conference on the Mechanical Properties of Non-Metallic Brittle Materials, which was held at the Royal Society of Arts, London, on April 1 and 2. It was attended by representatives from some forty industrial concerns, Government laboratories, research associations and university faculties, and from five West European countries.

The conference was opened by Mr. A. H. A. Wynn, scientific member of the National Coal Board. Mr. Wynn said that the complex structure of coal made it a particularly difficult substance to study. The Board hoped to learn from those who have a long tradition of scientific study of the mechanical properties of other brittle materials. Twenty-seven papers on eight different substances were to be presented, and it was clear that the research described had many common points of application.

The chairman of the first session, which was devoted to discussing strength in compression, tension, bending and shear, was Dr. L. C. Tyte, director of the Mining Research Establishment.

I. Evans and C. D. Pomeroy (Mining Research Establishment) discussed the random variability of the strength of coal in uniaxial compression and the dependence of mean strength on the size of specimen. A 'weakest link' theory, based on the probability of the propagation of cracks, was developed to explain the observations. Its implications regarding the physical nature of the breakage and the ultimate structural elements of the coal were considered. R. Jones (Road Research Laboratory) described recent work on the failure of concrete in compression and flexure. Ultrasonic pulse techniques showed pre-cracking parallel to the direction of loading to occur in test cubes in compression at 40–70 per cent of the failing load. It was considered that the cracks arose from local bond failures between the aggregate and cement. The strength of gypsum plaster as a function of the percentage of voids was discussed by K. K. Schiller (British Plaster Board (Holdings), Ltd.). The voids depend on the excess quantity of water in the original mix. Theoretical relationships for the fractional reduction of strength due to porosity were derived and shown to be in good agreement with experimental results.

A. J. Newman (Building Research Station) described recent research on the influence of the method of testing upon the results obtained in compressive strength tests of bricks. This work led to the selection of the method of test now included in British Standards for bricks.

Mr. B. Sugarman (British Glass Industry Research Association) introduced Miss P. Walton's review of the micro- and macro-strength of glass. Specification of strength is difficult because of the large number of influences to which it is susceptible and the wide scatter of results under apparently identical test conditions. The strength of glass fibres is very dependent on the drawing conditions and, contrary to earlier results, is not necessarily a function of the dimensions. Strength is also affected by surface conditions, time under load and by immersion in water. Although glass can show a strength of about 400,000 lb./in.^{2} under basic test conditions, this may fall to some 4,000 lb./in.^{2} in use.

The complexity of the breakage phenomena occurring in apparently simple compression tests was brought out in a paper by Prof. Th. R. Seldenrath and J. Gramberg (Technical University, Delft). Cylindrical specimens of fine-grain rocks such as lithographic limestone, when uniformly loaded, fail by splitting parallel to the direction of loading. Glass sometimes fails in a similar manner, but in other instances shatters into many fragments. Coarse-grain rocks, such as marble, collapse with the formation of typical 'shear cones'. The lateral dilatation of the cylindrical specimens is a maximum at about a quarter of the specimen height from either end and less in the central plane.

Triaxial compression tests at confining pressures up to 4,000 lb./in.^{2} on coal and coal-measure rocks, respectively, were described by S. A. F. Murrell and N. J. Price (Mining Research Establishment). The introduction of a confining pressure increases the compressive strength and changes the mode of fracture of coal from explosive bursting to shear failure. At high pressures, coals of markedly different properties under uniaxial compression possess almost equal strengths, and anisotropy also disappears.

The chairman commented on certain common features revealed in the papers. Materials of high intrinsic strength are weak in practice, strength is not reproducible but shows a statistical variation,

and mean strength diminishes with increasing size of specimen. These observations are consistent with a material permeated by cracks, whether visible or not. Theoretical approaches are based on this assumption, following Griffith's classical work on glass. Collateral evidence of the influence of cracks is provided by the triaxial loading tests.

For the second session, on elasticity and creep, the chairman was Dr. F. M. Lea, director of the Building Research Station of the Department of Scientific and Industrial Research.

Prof. A. D. Ross (King's College, London) outlined the relative contributions of elasticity, creep and shrinkage to the total strain in concrete, emphasizing the significance of the latter two factors. Rheological models and theories advanced to explain the observed phenomena were discussed. Prof. R. H. Evans (Leeds) dealt with the properties of concrete and other building materials when subjected to rapid rates of loading. Values for the modulus of elasticity obtained by static and dynamic tests differ, and anomalous values are found for many materials at very low loads. These are attributed to internal stresses.

Various aspects of the strength of ceramic materials were described in a paper presented in three parts, from the British Ceramics Research Association. A. Dinsdale and W. T. Wilkinson critically examined methods of measuring impact strength. The results for any one material and type of test show a wide variation, and tests differ in their ability to discriminate between materials; none is fully satisfactory. The system most likely to yield results that can be interpreted in terms of an inherent property of the material involves the use of unrestrained test pieces. Fatigue from repeated blows is observed when the impact points are distributed but not when they coincide. Sonic testing of ceramic refractory materials was described by W. R. Davies and J. F. Clements. The ratio of the dynamic modulus of elasticity to the modulus of rupture is practically constant and can be used both to estimate transverse strength, and as a possible index of resistance to thermal shock. Sonic resonance methods have been used to detect cracking and 'spalling' due to thermal shock. K. Pate and W. Noble described stress–strain relationships in heavy clay products. Thermal expansion, elasticity and elastic hysteresis were considered, together with the partially irreversible changes occurring during cyclic wetting and drying. It was concluded that no single test is sufficient to assess durability.

H. W. Davidson and H. H. W. Losty (General Electric Co., Ltd.) described a study of the elastic and plastic properties of carbon and graphite. They found it possible to rationalize these properties and the changes with temperature, in terms of the movement of layer planes within the graphite crystallites without reference to the gross grain structure, and to account qualitatively for the behaviour on graphitization and neutron irradiation.

N. B. Terry and W. T. A. Morgans (Mining Research Establishment) described studies of the rheological behaviour of coal. The coals examined show transverse isotropic elasticity, with dynamic moduli higher than the static moduli. Measurements of creep and internal damping have led to the suggestion of a type of mechanical model that would simulate coal. The elastic anisotropy was attributed to microcrack structure. F. J. Hiorns (British Coal Utilization Research Association) used vibrating strips of coal to study the dynamic Young's modulus and internal friction over the temperature-range 20°–180° C., including water absorption effects. Complex changes with water content were reported.

P. Murray, J. Williams and D. T. Livey (Atomic Energy Research Establishment, Harwell) gave data on the effects of porosity and microstructure on the mechanical properties and resistance to thermal shock of high-temperature materials (pure oxides). The importance of low porosity and fine grain size was emphasized. Improvement in resistance to thermal shock depends mainly on increased strength, which demands low-porosity fine-grain material. Treatment to minimize the effects of surface microcracks may lead to significant improvements in strength.

The chairman, in opening the discussion, directed attention to the commonly observed differences between instantaneous and long-period moduli, and warned that the success of similar 'spring and dashpot' models in representing the behaviour of different materials did not necessarily mean that the phenomena arose from common causes. He remarked also on the broad scatter of results characteristic of impact testing and wondered if theoretical approaches similar to those used in respect of compression and tensile strength could be applied.

Mr. H. T. Ramsay, director of the Safety in Mines Research Establishment, took the chair for the third session, on dynamic loading, impact and fragmentation.

E. N. Fox (Cambridge) has studied the strength of concrete beams subjected to short-duration flat-topped stresses, applied by using the stress–yield characteristics of a steel wire arresting a falling weight. For pulses of 10–100 m.sec. duration the results exhibited considerable scatter but indicated the strength to be, on average, about 35 per cent greater than the static strength. H. Green (Building Research Station), dealing with impact testing of concrete, emphasized the importance of the restraints imposed on the specimen and found that apparatus based on the ballistic pendulum is more satisfactory than drop-weight methods. The resistance of 4-in. concrete cubes to repeated blows is influenced by the shape and surface texture of the coarse aggregate used in the concrete.

R. Teale (Mining Research Establishment) described experiments in which cubes and ridges of rock of various cross-sections, attached by one face, were broken from the parent blocks by wedging and by lateral overturning forces. Wedging is inefficient because of frictional losses. The overturning forces increase as the 1·7 power of the linear dimensions and are roughly proportional to the compressive and shear strengths of the rocks. For ridges, shallow and deep modes of breakage are observed, depending on the width/height ratio. Studies of the penetration of a roller bit into concrete containing a strong rock aggregate were described by N. J. Price and R. Shepherd (Mining Research Establishment). The crushing strength of the concrete was its most significant property affecting penetration; the percentage and the particle size of the rock aggregate were not critical.

S. Paterson (Imperial Chemical Industries) reported studies of the energy partition in shattering stone blocks with an explosive charge. 'Balanced' charges communicate 10 per cent or less of their energy to the target block, not more than 2 or 3 per cent being energy of mass movement, while the remaining 90 per cent resides in the explosive products.

R. J. Hamilton and G. Knight (Mining Research Establishment) found the size distribution of the fine debris (100μ to 1μ in size) produced in the mechanical breakage of coal and rock to be constant in form for each material, but the quantity depends on the breakage process. Stronger materials on shatter produce less total dust than weaker ones, but a greater proportion is dispersed into the atmosphere. H. C. Grimshaw (Safety in Mines Research Establishment) reported similar size distributions from rocks shattered by explosives. Increasing the weight of charge increases the production of fine dust but has little effect on the size distribution. Water infusion reduces the amount of fine dust.

The chairman commented that a number of the papers gave rather unexpected results and confirmed the value of small-scale laboratory work before designing large machines. The constancy of size distributions for very varied breakage processes remains a surprising feature and the results reported, which extend to particles of respirable size, are highly significant for the mining industry.

The chairman of the fourth session, on the action of tools, was Dr. W. Idris Jones, director-general of research in the National Coal Board.

Four papers, all from the Mining Research Establishment, dealt with the action of wedge-type tools on coal. M. J. Dumbleton, M. J. O'Dogherty and R. Shepherd described laboratory experiments in 'ploughing' the face off a block of coal, and related the cutting force to the blade angle, depth of cut, strength properties and orientation of the coal specimen. Theoretical aspects of this process were considered by I. Evans, who assumed that the material fails in tension. C. D. Pomeroy gave experimental results for the effect of lateral pressure on the coal specimen on the ploughing forces. The entry of a wedge into specimens with one free face was the subject of a paper by I. Evans and S. A. F. Murrell.

J. H. Brown and C. D. Pomeroy studied friction between coal and metal surfaces.

The chairman commented on the absence of papers on materials other than coal in this session, but considered that the coal industry's problem is probably unique in requiring breakage to handleable size but not smaller. Considerable knowledge exists of metal cutting processes which might be applicable to coal and other brittle materials. There are considerable problems in establishing the relevance of basic measurements to more complicated processes such as ploughing, and further problems in proceeding from the laboratory to underground mining conditions.

The proceedings of the conference will be published in book form.

W. H. WALTON

INTERNATIONAL CONGRESS OF APPLIED PSYCHOLOGY

THE thirteenth International Congress of Applied Psychology was held at the University of Rome during April 9–14. Opening discourses by Prof. Canestrelli, the president, and by Profs. A. Gemelli and H. Piéron gave a conspectus of the scope of the congress and an account of the historical development of applied psychology. More than six hundred participants attended from thirty countries, and some 250 papers were presented. These covered a much wider range of subjects than at previous meetings, a novel feature being the special attention given to medical and, particularly, to legal psychology.

Plenary discussions were devoted to psychological aspects of training industrial managers, medical men, teachers and men of law. The other sessions were occupied, according to this four-fold division, with symposia and individual papers on more general industrial, medical, educational and legal questions.

The sessions on occupational psychology were less concerned with traditional problems of selection, training and environmental conditions of work than with newer questions, such as the specification of criteria for judging the worker's efficiency, the design of tools and machines, the human consequences of automation, industrial mobility, and the vocational rehabilitation of disabled workers. The medical meetings were mainly occupied with personality in physical illness, causes of abnormal behaviour in childhood, effects of hospitalization, analysis of the ideas of normality and abnormality, and socio-psychological aspects of critical physiological phases (for example, pregnancy, ageing) and of psychosomatic medicine. Themes in the educational sessions included the teacher–pupil relationship as a factor in scholastic success, educational and vocational guidance, practical applications of learning theory, 'group dynamics' in the classroom, and the adjustment of school programmes to varying levels of mental development. Finally, the sessions on legal psychology were directed to the problem of evaluating testimony, psychological examination of the accused, the study of criminal gangs, and the readjustment of discharged prisoners.

No participant could attend all the meetings, some of which were held simultaneously. One can therefore do little more than give a personal impression of a rather arbitrary selection of papers widely differing in form and content.

In the industrial section Dr. M. Roche, from Paris, made out a strong case for placing the training of driving instructors on a sound pedagogical basis, so as to ensure that only those who are themselves adequately qualified instructors should be permitted to teach others. Prof. G. Westerlund reported a large-scale statistical and 'inter-disciplinary' study of industrial accidents in Sweden. He suggested that accidents are more likely to occur when the worker is new to his job or environment, when his training is inadequate, and when equipment is used to an end for which it was not designed.

Dr. E. V. Gurijanov, of the Academy of Educational Sciences in the U.S.S.R., gave an impressive account of researches at the Laboratory of Labour Psychology, of which he is director. Their aims, he said, were not only to raise the individual's productivity, but also to create the most favourable conditions for the human operator, to improve his vocational skills and aptitudes, and encourage him to adopt 'a creative attitude' towards the solution of industrial problems.

Of more theoretical interest were papers by Mr. P. Bertelson and Mr. R. D. Shepherd, respectively, who studied the response times to stimuli varying in the probability of their appearance. Mr. Bertelson considered the effect of redundance of signals in a sequential task, while Mr. Shepherd was specially

concerned with common movements made without visual guidance, and he measured the response time in blind positioning reactions made in various emergency conditions.

Two French investigators, C. Benassy-Chauffard and J. Pelnard, analysed the occupational mobility of young workers by the use of methods (developed by Dr. J. M. Faverge) based on the theory of information, whereby the importance of both personal and social factors is assessed. An instructive report on workers' mobility in north Italy was provided by M. Cesa-Bianchi and E. Spaltro. A fresh approach to the study of vocational interests was made by A. Rodger, S. Wiegersma and L. Ancona.

In the medical sessions Prof. L. S. Hearnshaw and H. D. Paul described the present position of psychology in British and German medical schools, respectively. The wide interest in the effects of hospitalization was shown by studies from France, Czechoslovakia, Italy and Great Britain. G. Trentini discussed the immediate effects of hospitalizing cancerous patients. The impact of hospitalization on young children who are chronic invalids or who suffer from organic disability was described by R. Gaddini and Prof. R. W. Pickford. The latter also explained the principles on which successful psychotherapy was based. A first report on the usefulness of training courses by correspondence for patients staying for long periods in British hospitals was given by Dr. H. G. Maule.

Material of a different type was offered by Prof. O. Miyagi, of Tokyo, in the form of a clinical analysis of social pathology in which he contrasted the forms and incidence of mental disorder encountered in Japan with those met in Europe. He also cited characteristic war-time rumours occurring in Japan and compared them with those found by Prof. G. W. Allport among Americans in war-time. Other noteworthy papers included an experimental study by Mr. P. Sainsbury, who claimed, on the basis of electromyographic observations, that individuals tend to preserve a fairly constant level of muscle tension, as Freud suggested, and that gestural movements also have a characteristic level in the individual, such movements as well as conversational gestures increasing in states of anxiety.

An important session on educational psychology was devoted to a symposium on the evaluation of educational achievement ('docimology') presided over by Prof. R. Bonnardel. Other interesting papers were read by Prof. P. E. Vernon on the assessment of higher intellectual qualities, by Mme. Tabouret-Keller on the elimination of errors in orthography, by Mrs. T. G. Thurstone on the improvement of verbal comprehension, and by Prof. Rosca from Roumania on the effect of alternating activities on proficiency in school-work. He showed by careful experiments that the alternation of activities belonging to different (Pavlovian) signal systems is more efficacious than alternation within the same system.

Far fewer papers were devoted to legal psychology than to the other three themes, but a wide range of subjects revealed growing interest in this field. Apart from the topics already mentioned above, one session was concerned with social influences on delinquency with reports by G. Cohen-Séat, E. Valentini, F. Rabaye and F. M. Raeven on favourable and adverse features in the influence of the cinema. New light on the mind of the homicide was thrown by Dr. A. Paolella's study of projective tests administered to a group of twenty murderers and by Dr. A. Ginsberg's comparable investigation of a mixed group of criminals. A valuable paper on correctional psychology, based on extensive experience at one of the most advanced prisons in Switzerland, was provided by W. Haesler.

It only remains to add that the location of the Congress provided the participants with excellent opportunities for refreshing their memories of the *Forum Romanum* as well as stimulating their scientific and professional interest in newer developments in applied psychology.

John Cohen

DEVELOPMENT OF THE WEST AFRICAN ENVIRONMENT

THE second Interterritorial Conference of the West African Science Association was held at the University College of Ghana during March 23–29. The theme discussed was "The Development of the West African Environment", and with the aid of a grant from the Rockefeller Foundation, the Association was able to invite a number of scientists noted for their work in this field. The early history of the environment was discussed in relation to the geology, pedology, archæology and palæontology of the region, and its more recent history in relation to plant and animal ecology. Papers were also presented on the effects of recent biotic influences.

Investigations in the south-western Sahara carried out by Prof. Th. Monod, director of the Institut Français d'Afrique Noire, and M. R. Mauny, head of its Department of Prehistory and Archæology, showed how in this region relatively slight climatic changes between arid and semi-arid have resulted in marked changes in the flora and fauna. Such changes have also determined the course of human migrations in much of West Africa.

Dr. J. D'Hoore, of the Service Pédologique Interafricain, discussed the many factors involved in the interpretation of the formation of tropical soils, with special reference to the time factor. Further fundamental studies on the processes involved will be necessary before proper understanding of the changes caused in soils by the succession of dry and wet periods is obtained. There is, however, clear evidence from studies of pedogenesis that almost all forest areas of Africa have been subjected to dry periods, and that areas now dry have been under forest. Dr. W. Bruckner and Mr. O. Davies, both of the University College of Ghana, presented the evidence at present available concerning the changes that have taken place in the West African environment as shown by mantle rock and archæological studies in Ghana. Their evidence showed that the succession of pluvial and interpluvial periods in West Africa has followed a course similar to the glacial and interglacial periods in temperate regions. But, as Dr. L. S. B. Leakey, curator of the Coryndon Museum, Nairobi, emphasized, until much more evidence is gathered, reliable correlations between the evidence available from different sciences, and between, for example, East and West Africa, will be very difficult to achieve.

M. André Aubréville, formerly inspecteur-général des eaux et forêts de France Outre-mer, described how the influence of past climates is still apparent in the existence of relict species and savannah areas within what is now the high rain forest zone. But in a paper entitled "Derived Savannah—Derived from What ?" by Mr. R. W. J. Keay, principal research officer in the Nigerian Forest Research Department, the difficulty of distinguishing between relict and derived savannah areas was emphasized. The influence of man on the environment was also discussed by Prof. J. F. V. Phillips, of the University College of Ghana. It was apparent that much further work would be necessary before the relative importance of climatic changes and the activities of man on the vegetation of West Africa could be defined.

The probable relations of climatic and vegetational changes to the distribution of the mammalian fauna in past and present times was described by M. P. L. Dekeyser, head of the Zoology Section of the Institut Français d'Afrique Noire, and in a paper by the late Mr. Angus Booth. Mr. Booth, who was lecturer in zoology in the University College of Ghana and secretary to the Conference, died on March 16 after a short illness. During his six years in West Africa he had become the leading authority on West African primates.

In these papers the presence of relict faunas and the distribution of mammalian fossils provided further evidence for a succession of pluvial and interpluvial periods, but once again the dating of these periods was extremely difficult.

In summary, it may be said that while there was no indication of any disagreement in the probable succession of climatic changes as proposed by Sir George Simpson in his "Further Studies on World Climate" (*Quart. J. Roy. Meteor. Soc.*, **83**, 459; 1957), and ample evidence from a variety of sources to substantiate the theory that a succession of pluvial and interpluvial periods has occurred in the tropics, corresponding to the glacial periods of the temperate zone, further fundamental research into the geology, pedology, archæology, phytogeography and zoogeography is necessary before any well-defined chronological sequence can be established. The great importance of the succession of pluvial and interpluvial periods to a proper understanding of the natural history of this and other parts of Africa is very evident.

D. J. GREENLAND

AFRICAN CATTLE IN BRITISH DEPENDENT TERRITORIES

THE primary purpose of a survey carried out by D. E. Faulkner, director of veterinary services, Nyasaland, and Dr. H. Epstein, of the Hebrew University, Israel, was to describe the distinctive types and breeds of indigenous cattle found in British Dependent Territories of Africa*. Besides those of the Colonial territories, descriptions are included of the indigenous cattle of Southern Rhodesia (a self-governing British colony), the High Commission territories of Bechuanaland, Basutoland and Swaziland, and also of Libya and the Sudan. The cattle of the latter countries have been included because they help to throw light on the origins of the cattle of the Colonial territories adjacent or near them.

So far as possible, the types and breeds of cattle are described separately regardless of their territorial origin. In some cases it has been necessary to provide explanatory notes on the indigenous cattle of certain individual territories to make the existing situation clear. In the case of the Bechuanaland Protectorate and Southern Rhodesia, for example, owing to various historical movements and introduction of stock, the position would be confused without knowledge of the historical background.

The system of grouping and classification employed is as follows: all cattle have been grouped into three main geographical regions comprising East, Central and South Africa; West Africa; and North Africa.

The first of these regions, namely East, Central and South Africa, consists of three areas which are large and important regions in themselves. For the purpose of the survey it seemed better to group the three together in view of the extensive migratory movements of man and animals which, over the centuries, and commencing in East Africa, have occurred in great waves down the continental backbone through central Africa to the south.

The origin and history of African cattle are dealt with in some detail. Epstein has devoted considerable study over many years to this most important subject and the form of classification employed in the publication is almost entirely the result of his work.

The foundation groups into which the various types have been classified are as follows:

Humpless cattle:
  Longhorn humpless
  Shorthorn humpless
Humped cattle:
  Zebu cattle (1) Cervico-thoracic humped (neck-humped).
    (2) Thoracic-humped (chest humped).
  Sanga cattle (1) Cervico-thoracic humped (neck-humped).
    (2) Thoracic-humped (chest-humped).

In some regions no representatives of a group as such are now to be found, examples of this being the absence of longhorn humpless cattle in East, Central and South Africa, of the cervico-thoracic humped zebu in West Africa, and in North Africa the absence of every group except the shorthorn humpless cattle represented by the Libyan shorthorn.

Knowledge of the origin and history of African cattle types can play an important part in the efforts being made to improve them. From a slight study of the basic foundation groups from which the present breeds and sub-types of Africa have sprung, it is apparent that certain fundamental differences exist between them. To appreciate the genetical potentialities of these breeds and types it is important to know as much as possible not only of the parent stocks from which they came, but of the environmental conditions under which they and their parent stocks developed. Such knowledge is also of value when assessment has to be made of the effects of cross-breeding which has taken place over a long period between various breeds and sub-types.

* Colonial Office: Colonial Advisory Council of Agriculture, Animal Health and Forestry. Publication No. 5: The Indigenous Cattle of the British Dependent Territories in Africa, with material on certain other African Countries. Pp. xviii+186+119 plates. (London: H.M. Stationery Office, 1957.) 30s. net.

UNITED KINGDOM'S ROLE IN COMMONWEALTH DEVELOPMENT

THE Overseas Resources Development Bill received its second reading in the House of Commons on January 28, and in the House of Lords on February 18. It is intended to give effect to the policy for the Colonial Development Corporation, which is set forth in the White Paper* of July 1957, on the United Kingdom's role in Commonwealth development. The Government believes that it would be inappropriate for a United Kingdom statutory corporation concerned especially with the United Kingdom's responsibilities towards its dependent territories to invest money in new schemes in any territory after independence, although the Government would be happy to see the Corporation's managerial experience continue to be available to any newly independent Commonwealth country, or to any Commonwealth country which might desire it, and this is provided for under Clause 1. The Government also agrees with the Corporation's view that further capital will be required if the Corporation is to embark on fresh projects in Colonial territories, and Clause 2 of the Bill increases the amount which it may borrow and have outstanding at any one time from £100 million to £150 million, and the amount which may be advanced from the Exchequer to the Corporation from £100 million to £130 million outstanding.

As the Secretary of State for the Colonies, Mr. Lennox-Boyd, explained in moving the second reading, the Bill is concerned with only one section of the broad field covered by the White Paper. Over the years 1953–56 the average investment in the whole Commonwealth, including special assistance to various Colonial territories, was nearly £200 million a year, representing 1·25 per cent of our average gross national product, or 7–8 per cent of our gross fixed investment at home. It is estimated that in the decade 1946–57, 70 per cent of the external capital invested in the sterling Commonwealth came from the United Kingdom, 15 per cent from the United States, 10 per cent from the International Bank for Reconstruction and Development, and 5 per cent from other sources. The Bill was generally welcomed, though reservations were expressed as to whether the increase in capital was sufficiently large, and the Government's view that reliance should be placed on capital from private sources was challenged by Lord Lucan and Lord Milner. The Earl of Perth, in replying, pointed out that private sources had invested fourteen times as much as the Council Development Corporation in the Colonies during 1954–56.

The sections in the White Paper of most direct interest to the scientist and technologist—those dealing with technical co-operation and with co-operation in the field of nuclear science—lay outside the scope of the debate. As regards technical co-operation, it is estimated that 4,234 Commonwealth students are taking courses at United Kingdom universities and university colleges in the current academic year and about 2,000 at technical institutes, etc. Under the Colombo Plan Technical Co-operation Scheme it is planned to spend £750,000 for Commonwealth countries and £250,000 for foreign countries in the current financial year, and the Government believes that the sum of £7 million to be made available for the seven years from April 1956 should meet probable requirements under the Colombo Plan in that period.

The section on nuclear science reviews the development of co-operation in this field and then affirms the Government's intention to give all possible assistance to other Commonwealth countries, including the Colonial territories, in developing nuclear energy to meet their individual requirements. The Atomic Energy Authority does its best to give priority to candidates from other parts of the Commonwealth in its own schools, and Commonwealth countries intending to establish a nuclear project of their own can look to the Authority for help on organization and objectives, and advice on design of laboratories, selection of equipment, safety precautions, etc. Nuclear scientists from Commonwealth countries are to be invited to an informal meeting in the United Kingdom following the 1958 United Nations Conference on nuclear energy.

* The United Kingdom's Role in Commonwealth Development. Pp. 18. (Cmnd. 37.) (London: H.M. Stationery Office, 1957.) 1s. net.

TURNOVER OF PROTEIN IN A NON-MULTIPLYING ANIMAL CELL

By Dr. H. HARRIS and J. W. WATTS
Sir William Dunn School of Pathology, University of Oxford

IF protein turnover is defined as concurrent synthesis and degradation of protein within the cell, the experiments of Hogness, Cohn and Monod[1], Rotman and Spiegelman[2] and Koch and Levy[3], have shown that in *Escherichia coli*, during the exponential phase of growth, no detectable turnover of protein occurs. These findings have led Hogness *et al.*[1] to question whether the proteins of animal cells turn over, it having been generally assumed, since the work of Schoenheimer[4], that they do. In recent discussions of the problem of turnover Cohn[5,6] has pointed out that the evidence on which the demonstration of protein turnover in animal cells rests is inconclusive; the results could be explained by concurrent multiplication and death of cells in the tissues or by secretion of protein by the cells. Cohn has suggested that a precise answer to this problem could be obtained by studying a homogeneous population of animal cells growing exponentially *in vitro*. A study of this sort has been carried out by Siminovitch and Graham[7], who found that in mouse fibroblasts growing exponentially in suspension cultures no turnover of ribonucleic or deoxyribonucleic acids occurred. However, in the animal, exponential multiplication of cells rarely, if ever, occurs. Some cells, such as those of the brain, undergo no multiplication at all during adult life; and in tissues where cells do multiply the rate of mitosis is normally adjusted to

replace, and no more than replace, the cells being lost from the tissue. Even if it were found that no turnover of protein occurred in a culture of animal cells growing exponentially, it cannot be assumed that this would necessarily hold true for those cells in the tissues which are not multiplying. It has been shown, for example, that an appreciable turnover of protein does occur in a strain of *E. coli* requiring leucine, when the multiplication of the cells is prevented by the omission of leucine from the medium[8]; and experiments on the rate of radioactive labelling of different enzymes in skeletal muscle have also given results consistent with the occurrence of protein turnover in the cells[9].

With these considerations in mind we thought it might be informative to examine the synthesis and degradation of protein in a homogeneous population of non-multiplying animal cells. For this purpose macrophages from the peritoneal cavity of the rabbit were used. These cells do not multiply *in vitro*, but they remain alive for many days. Experiments extending over several hours can be carried out under conditions where it is possible to confirm both by direct observation and by cell count that no death of cells has occurred. Since living macrophages are motile, a dead cell can, with experience, be detected at a glance.

The macrophages were obtained from the peritoneal cavity of the rabbit some days after intraperitoneal injection of liquid paraffin[10]. The exudate was spun at 220*g* for 3 min. and the cells suspended in a medium containing 10 per cent of rabbit serum and 90 per cent of Hanks' solution. Aliquots of this suspension containing about 10^6 cells were introduced into Carrell flasks. The macrophages settled on the floor of the flasks and at 37° C. adhered firmly to the glass. After 30 min. the medium was withdrawn and the cells adhering to the floor of the flasks washed with physiological saline. Erythrocytes, lymphocytes and dead cells do not adhere to glass, and polymorphonuclear leucocytes, under these conditions, adhere poorly; washing the adherent layer of cells thus removes all but living macrophages. These were maintained in a medium consisting of 20 per cent of dialysed rabbit serum and 80 per cent of Eagle's basal medium[11] from which valine was omitted.

The synthesis and degradation of protein in the macrophages was studied by measuring the incorporation and release of L-valine-1-^{14}C. This amino-acid was chosen because under the conditions of the present experiments valine underwent very little conversion to other amino-acids. Hydrolysis of macrophage protein into which valine-^{14}C had been incorporated showed that 99 per cent of the carbon-14 in the protein was in valine; traces of carbon-14 appeared in glutamic acid, aspartic acid, glycine and proline. The amount of carbon-14 incorporated into the protein was thus an accurate measure of the amount of valine-^{14}C incorporated. This was added to the medium to give a final concentration of $5 \times 10^{-4} M$ (1·5 μc. of L-valine-^{14}C per ml.); at this concentration incorporation was not limited by the amount of valine-^{14}C in the medium.

The macrophages were harvested by removing the medium from the flask, washing the cells adhering to the floor with three changes of physiological saline, and then introducing a small volume of distilled water containing 1 per cent of the detergent 'Teepol'. The detergent solution removed the cells from the glass and completely disrupted them. An equal volume of 10 per cent trichloracetic acid was added to the solution containing the disrupted cells, and the precipitate heated at 90° C. for 30 min. to remove nucleic acids. Lipids were extracted with hot alcohol/ether. The residue was the fraction referred to here as the macrophage 'protein'. The specific activity of the protein was measured in terms of its ninhydrin value after hydrolysis with 6 *N* hydrochloric acid[12].

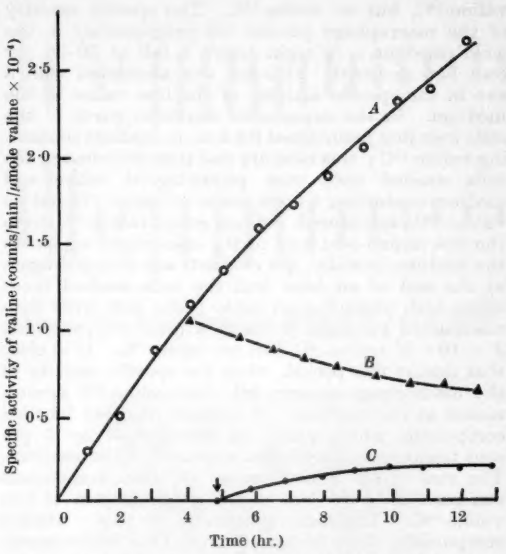

Fig. 1. ○—○, *A*, incorporation of L-valine-^{14}C into the protein of the macrophages; ▲—▲, *B*, fall in the specific activity of the macrophage protein when the cells, having incorporated valine-^{14}C, are maintained in a medium free from valine-^{14}C; ●—●, *C*, rise in the specific activity of the free valine in the medium when cells, having incorporated valine-^{14}C, are maintained in a medium free from valine-^{14}C

The results of typical experiments are shown in Fig. 1. Curve *A* represents the incorporation of valine-^{14}C into the macrophage protein over a period of twelve hours. The rate of incorporation deviates slightly from linearity. Analysis of specific activity showed that at the end of twelve hours about 10 per cent of the valine in the protein was labelled. D-valine was not incorporated in this way; the incorporation of L-valine-^{14}C was virtually unaffected by a large excess of D-valine in the medium. Sodium azide, at a concentration of $5 \times 10^{-3} M$, reduced the incorporation of valine-^{14}C by about 50 per cent. Hydrolysis of the labelled protein with 10 *N* hydrochloric acid at 37° C. over six days showed that the valine-^{14}C had actually entered into peptide bonds: there was a progressive release during hydrolysis of large numbers of peptides containing this acid; these peptides yielded free valine-^{14}C on complete hydrolysis. The incorporation of valine-^{14}C in the present experiments thus has all the characteristics of protein synthesis. There was, however, no net protein synthesis. Measurements of the ratio of protein to deoxyribonucleic acid at the beginning and end of the experiments showed no increase in the amount of protein per cell.

Curve *B* shows the results of an experiment in which the cells were first maintained in medium containing valine-^{14}C for four hours, then washed three times with physiological saline and then maintained for a further eight hours in a medium containing

valine-^{12}C, but no valine-^{14}C. The specific activity of the macrophage protein fell progressively in the 'cold' medium; in eight hours a fall of 30–35 per cent had occurred. This fall was associated with a rise in the specific activity of the free valine in the medium. In the experiment shown in curve *C* the cells were first maintained for 4 hr. in medium containing valine-^{14}C; this medium was then withdrawn, the cells washed once with physiological saline and medium containing a large excess of valine-^{12}C, but no valine-^{14}C, introduced. Since some valine-^{14}C from the free amino-acid pool of the cells might appear in the medium initially, the medium was changed again at the end of an hour and the cells washed three times with physiological saline; the cells were then maintained for eight hours in a medium containing 2×10^{-4} *M* valine-^{12}C, but no valine-^{14}C. It is clear that during this period, when the specific activity of the macrophage protein fell, free valine-^{14}C accumulated in the medium. A number of other labelled compounds which were not precipitated by 5 per cent trichloracetic acid also appeared in the medium. The rise in the concentration of these compounds ran parallel to the rise in the concentration of free valine-^{14}C. The most prominent of these labelled compounds, which contained most of the trichloracetic acid-soluble carbon-14 not present as free valine, was isolated and subjected to acid hydrolysis. It yielded free valine-^{14}C and other ninhydrin-reacting substances. Preliminary investigations suggest that the labelled compounds appearing in the medium together with free valine-^{14}C are peptides containing valine-^{14}C. The total amount of trichloracetic acid-soluble carbon-14 in the medium at the end of 8 hr. was, within experimental error, equal to the amount of carbon-14 lost from the protein. The rate at which valine-^{14}C was released from the protein was unaffected by a large excess of L-valine in the medium. These findings leave little doubt that the fall in the specific activity of the protein was due, at least in large part, to protein breakdown. This breakdown was relatively insensitive to azide. A concentration of 5×10^{-3} *M*, which produced a 50 per cent reduction in the amount of valine-^{14}C incorporated into protein in 8 hr., reduced the fall in the specific activity of the protein over the same period by only 15 per cent. The fact that the breakdown of the protein is little affected by sodium azide and involves the release of peptide-like compounds as well as free amino-acids suggests a process resembling proteolysis. Since release of free valine from the protein into the medium and incorporation of free valine from the medium into the protein occur simultaneously, it is clear that recycling of valine occurs. The finding that both incorporation and release are curvilinear functions is consistent with the occurrence of recycling.

If it is accepted that the incorporation and release of valine-^{14}C in the present experiments represent synthesis and degradation of protein then it is clear that in the macrophage turnover of protein occurs on a large scale. If it is found that turnover of this sort occurs in animal cells during the exponential phase of multiplication, then there would appear to be a fundamental distinction between animal cells and bacteria in this respect; if, however, the proteins of animal cells, like their nucleic acids, are stable during exponential multiplication, then the distinction would appear to lie not between bacterial and animal cells but between multiplying and non-multiplying cells, whether bacterial or animal.

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CHROMOSOMAL EVOLUTION IN THE PODOCARPACEAE

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As recently emphasized[1], there is a correlation between the stability of chromosome numbers and the length of the reproductive cycle, reaching an extreme in the unvarying basic numbers of most families of slow-growing, long-lived trees composing the gymnosperms. We wish to direct attention to an exception to the rule of constancy. The Podocarpaceae, far from being stable, show a surprising variation in chromosome numbers which points both to the past and to the future.

The 52 species here dealt with cover all genera of the family (Tables 1 and 2), including *Podocarpus* as revised by Buchholz and Gray[2]. All specimens have been carefully identified; the material is largely of known wild origin. Every plant dealt with is represented by a voucher herbarium specimen held at this Division.

The results demonstrate a regular numerical relationship between the two classes of chromosomes, *V*'s and *I*'s, such that with each successive change in basic number a *V* replaces or is replaced by two *I*'s. This suggests that we are dealing with either a descending basic series through 'fusion' (unequal interchange) of non-homologous *I*'s with subsequent elimination of the associated and presumably genetically inert centric fragment; or with an ascending series through 'fission' (misdivision) of *V*-chromosomes.

On either scheme, hybrids between two closely related species the basic number of which differs by 1, 2, etc., should reveal the corresponding number of trivalent associations at meiosis. This condition is fulfilled by the natural hybrid ($2n = 36$) between *Podocarpus nivalis* ($x = 19$) and *P. hallii* ($x = 17$) (Figs. 1–2). A similar evolutionary sequence, demonstrable by marker chromosomes, occurs in *Dacrydium* and in Sect. *Stachycarpus*; is probable in *Eupodocarpus A*; and may be inferred in Sect. *Nageia*.

Table 1. CHROMOSOME COMPLEMENTS OF THE PODOCARPACEAE

Species	Country of origin	2n	Pairs $V + I$	$x = n$
Sect. *Stachycarpus*				
Podocarpus andinus	Chile	38*	1 + 18	19
P. spicatus	N.Z.	38	1 + 18	19
P. ferrugineus	,,	36	2 + 16	18
Sect. *Sundacarpus*				
P. amarus	Queensland	38	1 + 18	19
Sect. *Eupodocarpus C*				
P. salignus	S. America	38†	?	19
Sect. *Eupodocarpus D*				
P. nivalis	N.Z.	38	1 + 18	19
P. hallii	,,	34	3 + 14	17
P. totara	,,	34	3 + 14	17
P. acutifolius	,,	34	3 + 14	17
Sect. *Microcarpus*				
P. ustus	New Caled.	36	2 + 16	18
Sect. *Nageia*				
P. nagi	Japan	26	7 + 6	13
P. blumei	Indonesia	20	10 — —	10
Sect. *Afrocarpus*				
P. falcatus	S. Africa	24‡	8 + 4	12
P. gracilior	,,	24*	8 + 4	12
Sect. *Eupodocarpus A*				
P. elongatus	,,	22‡	9 + 2	11
P. henkelii	,,	22‡	9 + 2	11
		20*	10 — —	10
P. latifolius	,,	20‡	10 — —	10
Sect. *Polypodiopsis*				
P. comptoni	New Caled.	20	10 — —	10
P. minor	,, ,,	20	10 — —	10
P. palustris	,, ,,	20	10 — —	10
P. vitiensis	Fiji	20	10 — —	10
Sect. *Dacrycarpus*				
P. dacrydioides	N.Z.	20	10 — —	10
P. imbricatus	Fiji; Indon.	20	10 — —	10
P. vieillardii	New Caled.	20	10 — —	10
Microcachrys tetragona	Tasmania	30	5 + 10	15
*Dacrydium franklinii**	,,	30*	5 + 10	15
D. intermedium	N.Z.	30	5 + 10	15
D. laxifolium	,,	30	5 + 10	15
D. biforme	,,	24	4 + 8	12
D. kirkii	,,	22	5 + 6	11
D. bidwillii	,,	18	7 + 2	9
D. colensoi	,,	20	10 — —	10
D. cupressinum	,,	20	10 — —	10
D. elatum	Fiji	20	10 — —	10
D. araucarioides	New Caled.	20	10 — —	10
D. balansae	,, ,,	20	10 — —	10
D. guillauminii	,, ,,	20	10 — —	10
D. lycopodioides	,, ,,	20	10 — —	10
D. taxoides	,, ,,	20	10 — —	10
Acmopyle pancheri	,, ,,	20	10 — —	10
Pherosphaera hookeriana	Tasmania	26	7 + 6	13
P. fitzgeraldi	N.S. Wales	26	7 + 6	13
Saxegothaea conspicua	Chile	24§	8 + 4	12
Phyllocladus alpinus	N.Z.	18	9 — —	9
P. glaucus	,,	18	9 — —	9
P. trichomanoides	,,	18	9 — —	9

V, chromosomes median to submedian; *I*, chromosomes subterminal to subtelocentric.

* Determinations on cultivated plants, New Zealand.

† Recorded by Stiff (ref. 3).

‡ Moffett (unpublished); confirmed.

§ La Cour (unpublished); confirmed.

Table 2. CHROMOSOMES OF HOMOZYGOTES AND HETEROZYGOTES COMPARED IN SUBSECTS. *F*, *B* OF *Eupodocarpus*

Species	Source	No. of plants	Constitution	2n
Subsect. *F*				
P. longefoliolatus	Wild pop.*	1	17 prs. + $2A + 2B$	38
	New Cal.	3	17 prs. + $A'B' + A + B$	37
Subsect. *B*				
P. macrophyllus	?	?	19 prs.	38†
P. novaecaledoniae	Wild pop.*	4	17 prs. + $C'D' + C + D$	37
	New Cal.	1	17 prs. + $C'D' + 2C$	37
P. elatus	Cult.	2	16 prs. + $2E + 2F$	36
	plants	2	16 prs. + $E'F' + E + F$	35
	N.Z.	1	? ? ?	34
P. neriifolius	Cult.	1	15 prs. + $G'H' + G + H$	33
P. polystachyus	Bogor	1	15 prs. + $J'K' + J + K$	33

* Seedlings.

† Recorded by Mehra and Khoshoo (ref. 4).

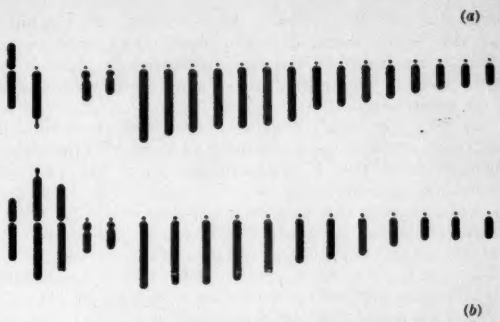

Fig. 1. Comparative chromosome idiograms of (top) *P. nivalis* ($x = 1\ V + 18\ I$) and (bottom) *P. hallii* ($x = 3\ V + 14\ I$)

Fig. 2. First metaphase in the hybrid *P. nivalis* × *P. hallii* showing 15 bivalents and 2 trivalents (× 1,500)

The additional material of Table 2 confirms and extends our conclusions in two ways. First, we are concerned with closely related sub-groups which clearly show an intra-specific chromosomal polymorphism of a kind very rarely observed in the plant kingdom; and this variation is based on the same principle which we believe plays a major part in the inter-specific chromosomal evolution of the Podocarpaceae as a whole. Chromosomal variation is therefore continuous, since it embraces both the homozygous (or partly 'fixed') and the heterozygous (or transitional) phases of the evolutionary succession.

Secondly, the finer analysis of the decisive chromosomal types provides a clue to the probable direction of evolutionary change. When the equivalent chromosome arms, A and A', of homozygote and heterozygote are compared (Fig. 3) they show a significant difference: A' lacks the marked proximal segment of A and is therefore consistently shorter than A. Such a difference, while an improbable consequence of misdivision in the V-chromosome $A'B'$, may well be due to 'fusion' of the I-chromo-

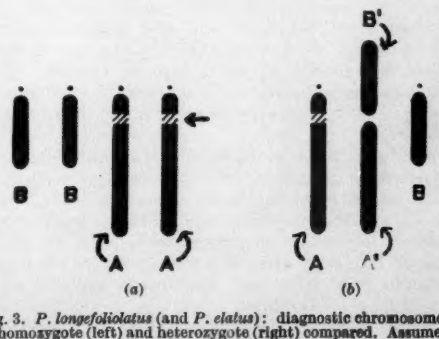

Fig. 3. *P. longefoliolatus* (and *P. elatus*): diagnostic chromosomes in homozygote (left) and heterozygote (right) compared. Assumed breakage point at arrow

somes A and B, provided that breakage in A occurs at the appropriate distance from the centromere. The A-chromosome is in fact differentially stained at this 'point of weakness', the assumed locus of breakage and interchange.

If, as the evidence suggests, a progressive reduction in basic number is a major factor in chromosomal evolution in the Podocarpaceae, then the process conceivably began at a higher level, $x = 20\ I$, giving a continuous series in which the number of 'fusions' corresponds to the number of V-pairs. At present it would be unwise to insist upon a one-way scheme of this kind, but such a sequence would represent continuous progress towards an economy of centromeres and stability of chromosomes.

The broader aspects of this investigation are discussed in a more detailed paper to be published elsewhere.

We thank Mrs. N. E. Gray, Emory University, for the identification of material from overseas; Dr. A. A. Moffett, Wattle Research Institute, Pietermaritzburg, and Dr. L. F. La Cour, John Innes Horticultural Institution, Hertford, for their careful cytological analysis of the species noted (Table 1). Our fuller account acknowledges the many contributions of living material essential to this study.

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A CORRELATION BETWEEN ELECTRICAL SURFACE CHARGE AND SOME BIOLOGICAL CHARACTERISTICS DURING THE STEPWISE PROGRESSION OF A MOUSE SARCOMA

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In a previous communication it was pointed out that the transformation of normal to tumour tissue is accompanied by an increase in negative electrical charge carried by the cells[1]. This difference was observed when a stilbœstrol-induced kidney tumour was compared with normal kidney cells and when a liver tumour was compared with normal liver cells. Other changes, apparently associated with the cell surface, have been observed in tissue culture[2]. It has now been possible to demonstrate a progressive change occurring in relation to the selective establishment of different sub-lines of the same tumour. An increase in the negative charge carried by the cells has been demonstrated in these sub-lines as they show an increasing tendency to grow in the ascites form.

These sub-lines of the *MC1M* sarcoma have been described by Klein and Klein[3]. The electrophoretic mobility of the following sub-lines has been examined.

(1) M_{SS} is the original solid line of the tumour that has been in continuous uninterrupted subcutaneous passage since 1945. When transferred to the peritoneal cavity it will not transform into a suspension of ascites cells but forms an extensive infiltrative growth of solid tumour masses. Lung metastases are formed very late in the development of the tumour and consist of compact intravascular emboli[4].

(2) M_{TLF} is a sub-line of M_{SS} that has been carried through a number of passages of ascitic fluid and afterwards re-implanted subcutaneously. When tested for the present experiments it was intermediate in behaviour, growing mostly as a solid tumour but also able to grow in ascitic fluid to a certain extent, although not nearly as well as the established ascites line.

(3) M_{AA} is the ascites sub-line produced from M_{SS} by serial selective transfer of ascitic fluid. Inoculation intraperitoneally causes a rapid increase of free cells with very little solid infiltration.

(4) M_{ASn} tumours are solid tumours produced by re-inoculation of M_{AA} subcutaneously. The index n denotes the number of uninterrupted serial passages in the solid form. These tumours, in contrast to M_{SS}, grow readily in the ascites form when inoculated intraperitoneally. Their subcutaneous growth is more infiltrative than M_{SS} and they form metastases in the lungs much earlier, the cells appearing diffusely scattered through the entire lung parenchyma as dissociated free cells[4].

Suspensions of each tumour were prepared as nearly as possible in an identical manner. $M/15$ mixed phosphate buffer was used in all cases for

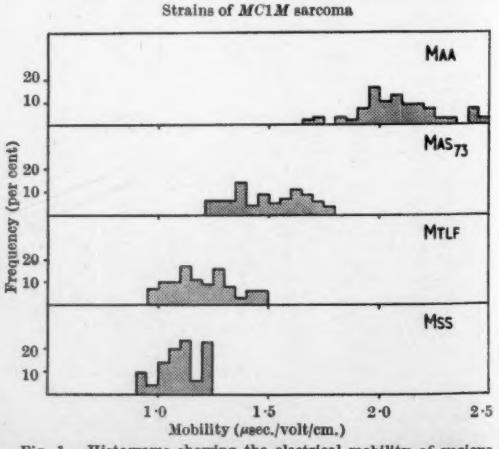

Fig. 1. Histograms showing the electrical mobility of various sub-lines of the *MC1M* sarcoma (stabilized after many transplants in the same situation)

preparation of suspensions, washing the cells and as the medium in which measurements were taken. The only difference in preparation was that the solid tumours had to be chopped and agitated in buffer to provide a suspension of cells, while ascites tumours had cells already in a suspension in the ascitic fluid and only needed washing and resuspending in buffer.

The mobilities of individual cells were measured as previously described[1,5] and the histograms are shown in Fig. 1. The distributions were found to be reproducible both between individual tumours of the same generation and between tumours of different generations. It will be seen that there is a progressive increase in negative electrical charge in passing from M_{SS} to M_{AA} sub-lines. No other physical or chemical differences between these strains have previously been detected. This indication of progressive change in the surface properties, as the tumour cells become increasingly malignant, agrees with the evidence that the cancer cells may be produced by a series of stepwise transformations[6-10] and that many tumours contain a mixed population of cells.

Observations were also made on the effect of changing the tumour's environment (Figs. 2 and 3). If the ascites form M_{AA} is re-implanted in the flank (M_{AS_1}) there is a considerable fall in mobility in this first transplant (Fig. 2). By the fourth transplant (M_{AS_4}) the mobility has risen to almost the same value as observed with the strain transplanted continuously in the flank ($M_{AS_{73}}$). If either the M_{AS_1} or the $M_{AS_{73}}$ tumours are transplanted back into the peritoneum, in the first transplant the mobilities rise to values slightly less than the value for the ascites form (M_{AA}) (Fig. 3). Evidently the cells are not immediately adapted to their new environments.

The changes seen in Figs. 2 and 3 could be due to adaptive modifications occurring in the cell surface when the cells are first placed in their new environment. They could also be accompanied by a progressive selection of cells more suited to the environment.

In conclusion, it may be said that the selection for a biological characteristic, namely, the ease of producing the ascites form, which also leads to the appearance of early metastases, is correlated with the progressive increase in negative electrical charge (Fig. 1). These observations are in agreement with those previously described[1] which indicate an increase in negative charge in passing from normal to tumour cell and suggest that as the cell acquires more malignant properties there is a further increase in electrical charge.

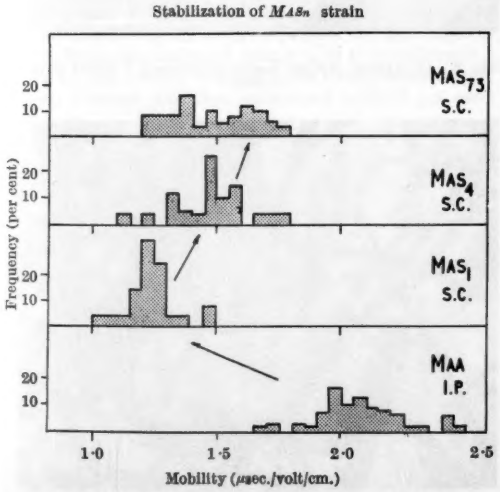

Fig. 2. Changes in mobility arising from changing the tumour environment. Ascites line transferred to flank; MAS_1 first transplant; MAS_4 is fourth transplant in the flank

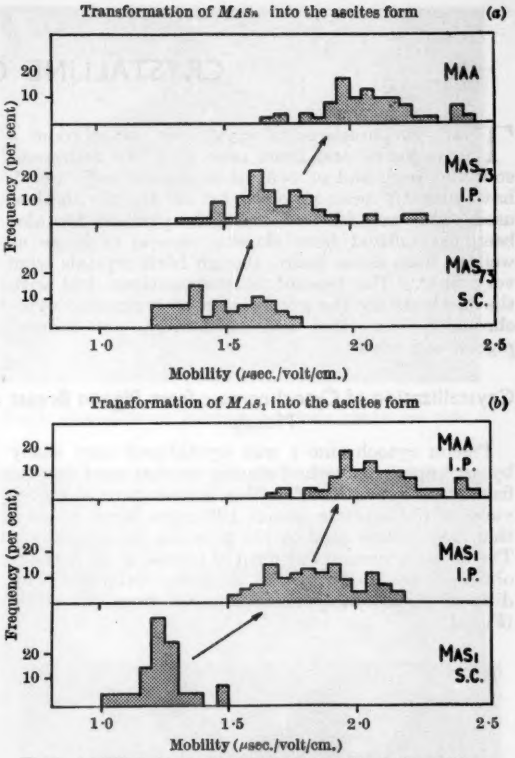

Fig. 3. (a) Effect of re-implanting MAS_{73} (stabilized after 73 transplants in flank) into the peritoneum; (b) effect of re-implanting MAS_1 (first transplant in flank) into peritoneum

We wish to express our thanks to Prof. A. Haddow for his interest in this work. We are most grateful to Dr. A. M. James for advice and help in the methods of measurement.

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CRYSTALLINE CYTOCHROME *c*

THE preparations of crystalline cytochrome *c* from yeast[1] and heart muscle of two mammals, cow and pig[2], and of two fishes, bonito and tunny[3], have recently been reported by us. By the method used previously for cow heart, the pigment has also been crystallized from skeletal muscle of horse as well as from horse heart, though both crystals were very fine[4]. The present communications deal with the methods for the preparation of crystalline cytochrome *c* from other sources, namely, cow kidney, pigeon and wheat.

Crystallization of Cytochrome c from Pigeon Breast Muscle

Pigeon cytochrome *c* was crystallized very easily by an improved method similar to that used for the fish heart cytochrome[3]. This source gave a higher yield of the crystals (about 100 mgm./kgm. muscle) than any source used in the previous investigations. The crystals were in the form of plates, as were those obtained by Bodo[5] from penguin, although they differed considerably in appearance from the latter (Fig. 1).

Fig. 1. Crystalline reduced cytochrome *c* (plate form, × 300)

Pigeon breast muscle (1 kgm.) was minced and suspended in an equal volume of 85 per cent saturated ammonium sulphate solution containing 0·5 *N* acetic acid. After standing for 48 hr. at about 10° C., the suspension was pressed and the residue washed with 55 per cent saturated ammonium sulphate solution of *p*H 4·5. About two litres of the combined extracts (about 55 per cent saturated ammonium sulphate, *p*H 4·6; purity about 0·04—expressed as the ratio of extinction at 280 mμ in oxidized state to that at 550 mμ in the reduced state, R_{280}^{550}) was adjusted to *p*H 7·0, and ammonium sulphate was added until the specific gravity was 1·22; then the suspension was filtered. Cytochrome *c* in the filtrate was precipitated by the modified methods of Keilin and Hartree, in which the *p*H of the filtrate was adjusted to 4·5 with trichloroacetic acid in the cold. The precipitate was immediately collected and dissolved in water (yielding about 100 ml. of red solution; *R*, 0·8). The solution was dialysed and cytochrome *c* was adsorbed on a column of 'Amberlite' *XE*-64 which had been equilibrated with ammonium phosphate buffer at *p*H 7·0 containing 0·1 gm.-ion of ammonium ion (hereafter abbreviated as 0·1 *N*-buffer). The column was washed with a large amount of the same buffer, and then cytochrome *c* was eluted with 10 per cent saturated ammonium sulphate solution at *p*H 9·0. The *p*H of the eluate was adjusted to about 9·0 and ammonium sulphate was added at 10° C. until approximately one-twentieth of the total cytochrome was precipitated out together with most of the impurities. The filtrate (about 10 ml.; *R*, 1·10) was dialysed, the cytochrome *c* was converted to an oxidized form, and chromatographed on a column of 'Amberlite' *XE*-64 equilibrated with 0·25 *N*-buffer, *p*H 7·0 (see refs. 1–3). Cytochrome *c* in the main peak of the effluent was concentrated by the adsorption and elution technique[1]. From the concentrated solution containing at least 3 per cent cytochrome *c*, the protein was crystallized after reduction in almost the same way as in the case of cow heart[2]. At the

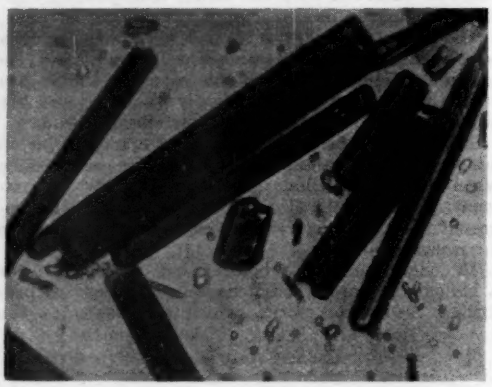

Fig. 2. Crystalline oxidized pigeon cytochrome *c* (prism form, × 300)

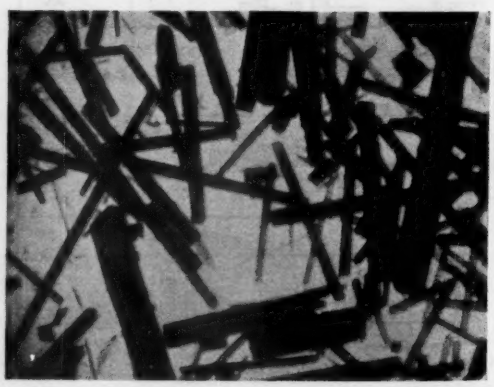

Fig. 3. Crystalline oxidized bonito cytochrome *c* (prism form × 300)

beginning of crystallization, considerable amounts of amorphous precipitate were found, but they were gradually transformed into crystals after a few days. Their recrystallization proceeded more rapidly (solution of the crystals; R, 1·20).

The present method differs somewhat from those reported for the crystallization of cytochrome *c* from cow, pig and fish hearts[2,3], but this method can be applied even more successfully for these sources than the previous ones.

It was reported earlier[1] that yeast cytochrome *c* could be crystallized in oxidized as well as in reduced form. However, crystals of the oxidized yeast cytochrome *c* were very fine, and oxidized cow heart cytochrome *c* has not yet been obtained.

In the case of pigeon muscle and bonito heart, cytochrome *c* in the oxidized form was easily crystallized in the same way as the reduced form except that ascorbic acid was omitted. The crystals of oxidized cytochrome *c* were plates or prisms (Fig. 2), and those of the fish cytochrome *c* were large needles or long prisms (Fig. 3). However, the oxidized cytochrome *c* is less stable than the reduced form and tends to suffer modification. The modified pigment, however, still shows the same absorption spectrum and biological activity as normal cytochrome *c*, but can easily be distinguished from it by resin chromatography[4,5]. It is therefore recommended that cytochrome *c* should be crystallized in the reduced state.

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Crystallization of Cytochrome *c* from Cow Kidney

It was impossible to obtain crystalline cytochrome *c* from cow kidney by the method used for muscle, since the kidney contains impurities which could not be sufficiently removed by that method. However, when the cytochrome was chromatographed on an 'Amberlite' *XE*-64 column in its oxidized form as usual, followed by a second run in its reduced form, the impurities were sufficiently removed to yield crystalline cytochrome *c*. The successful separation may be due to the different affinities for the resin of the oxidized and reduced forms of the cytochrome.

Cow kidney cortex (4 kgm.) was rinsed with water, coarsely minced, and then extracted with 85 per cent saturated ammonium sulphate solution containing acetic acid as before. After squeezing out with the aid of coarse 'Celite', the extracts (slightly brown solution, containing ammonium sulphate at about 50 per cent saturation; *c.* 8·5 l.; R, 0·02) was adjusted to *p*H 7·0, impure proteins were removed with ammonium sulphate (specific gravity, 1·22), and then cytochrome *c* was precipitated with trichloroacetic acid. Cytochrome *c* was dissolved in water (about 100 ml.; R, 0·45), and then adsorbed on the column according to the preceding method. The column was carefully washed with 0·125 gm.-ion of ammonium buffer, *p*H 7·0, until about a twentieth of the total cytochrome *c* in the main band was eluted. Only the part of the resin corresponding to the main band of cytochrome *c* on the column was transferred to another column, and cytochrome *c* was eluted as before (eluate about 20 ml.; R, 0·55). The eluate was fractionated with ammonium sulphate, dialysed, and then oxidized with potassium ferricyanide (about 40 ml.; R, 0·60). The oxidized cytochrome *c* was chromatographed as before and then cytochrome *c* in the main effluent was concentrated by the resin method[1] (concentrated main effluent, about 4 ml.; R, 0·95). The pigment was reduced by ascorbic acid and chromatographed using 0·2 *N* ammonium buffer of *p*H 7·0 on the column of 'Amberlite' *XE*-64 which had been equilibrated with

Fig. 4. Crystalline cow kidney cytochrome *c* (rosette form, × 200)

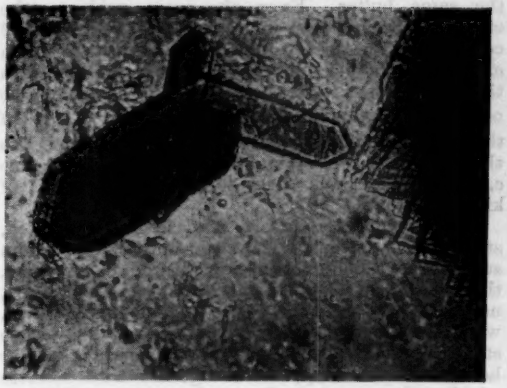

Fig. 5. Crystalline cow kidney cytochrome *c* (rosette and plate, × 200)

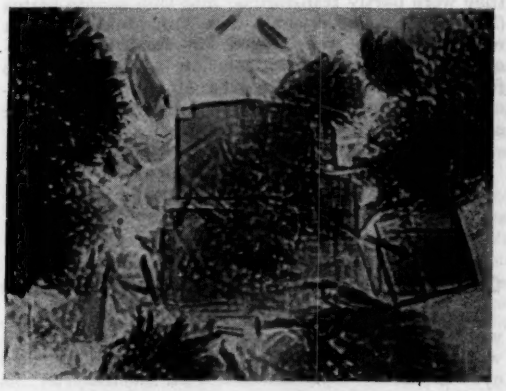

Fig. 6. Crystalline cow heart cytochrome *c* (rosette and plate × 300)

the same buffer. From the main peak in the effluent, cytochrome *c* was concentrated by a small column of the resin (second concentrated main effluent, about 0·5 ml.; R, 1·20) and crystallized in the same way as in the case of pigeon breast muscle or cow heart muscle. The extinction ratio, R_{280}^{550}, of the crystalline preparation was 1·26–1·30, which was the same as that of crystalline cow heart cytochrome *c*, and the yield was about 40 mgm. from 4 kgm. of kidney cortex.

The crystals usually appeared in about a week, standing the concentrated cytochrome *c* in ammonium sulphate solution at room temperature; in this state, the crystal forms were similar to those of cow heart, namely, rosettes (Fig. 4) or leaflets. However, when the suspension of the crystals was allowed to stand for about six months, considerably larger hexagonal plates appeared, together with rosettes which were composed of a number of plates (Fig. 5). When the suspension of the crystals of cow heart cytochrome *c* was allowed to stand for a long time, they were partly transformed into thin square plates (Fig. 6). Similar crystals were also obtained when recrystallization was carried out from highly concentrated cytochrome *c* solution. Therefore, the fundamental form of crystals of cow heart cytochrome *c* is apparently tabular although they appear as needles when they are very small.

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Crystallization of Cytochrome *c* from Wheat Germ

In order to crystallize cytochrome *c* of plant origin, wheat germ was chosen as a source material, as it was used by Goddard[7] for the isolation of purified cytochrome *c*. Crystallization from this material was much more difficult than from any one of the animal sources tested, due to the low content of the pigment, the difficulty of extraction and the presence of large quantities of impurities with adsorption characteristics similar to those of cytochrome *c*.

Wheat germ (10 kgm., containing about 30 per cent of wheat bran) was piled up in a large column and washed with ethyl acetate, which was circulated through the germ layer by evaporation and condensation for several hours. The washed and dried germ (about 9·5 kgm.) was twice extracted with 30 per cent saturated ammonium sulphate solution of *p*H 6·5 (first with 40 l. then with 30 l.) for 24 hr. each at 10° C. The residue was removed by squeezing out in a press with the aid of coarse 'Celite', and the slightly turbid, dark brown extract (about 50 l.) was salted out with ammonium sulphate at 95 per cent saturation. At this stage the content of cytochrome *c* was less than 0·01 per cent of the total protein, and the pigment could be precipitated completely with ammonium sulphate at 95 per cent saturation because of the presence of impuritities, although the purified pigment was not completely precipitated even by saturation of the salt. The precipitate was collected by filtration with 'Celite' and pressed to drain out, then suspended in 20 per cent saturated ammonium sulphate solution. The suspension was adjusted to *p*H 4·5 and kept at 4° C. for 30 min. in order to denature the impure proteins. After filtration, the filtrate (10 l.; $R < 0·001$) was fractionated with ammonium sulphate, and the fraction precipitated at

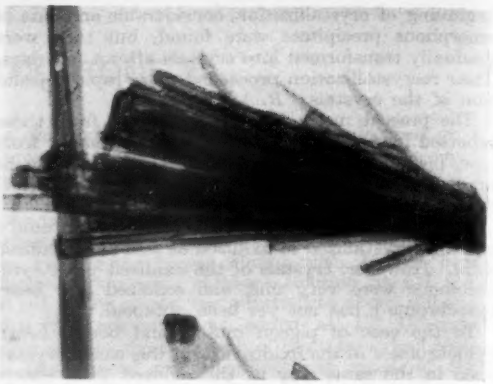

Fig. 7. Crystalline wheat cytochrome *c* (× 200)

75–95 per cent saturation was dissolved in water (1·2 l.; R, 0·006) and then dialysed against tap water. The dialysed filtrate (1·5 l.; R, 0·015) was passed through an 'Amberlite' *XE*-64 column (3 cm. × 20 cm.) equilibrated with 0·05 *N* ammonium buffer, *p*H 7·0, and the column washed with excess of the same buffer. Most of the cytochrome *c* formed a readily distinguishable band on the column and could thus be separated from most of the impurities. This part of the resin, corresponding to the cytochrome *c* band, was cut off, transferred to another column, and then the adsorbed cytochrome *c* was eluted with 0·3 *N* buffer, *p*H 7·0. The eluate (20 ml.; R, 0·35) was diluted three-fold with water and passed through a resin column (2 cm. × 20 cm.) treated with 0·1 *N* buffer, *p*H 7·0. The column was then washed with the same buffer. The cytochrome was then eluted with 0·2 *N* buffer (the second eluate, 40 ml.; R, 0·5) and chromatographed on another resin column equilibrated with 0·15 *N* buffer, *p*H 7·0. Cytochrome *c* in the main peak of the effluent was concentrated as before (main concentrated effluent, 4 ml.; purity, 0·8), reduced with ascorbic acid, and then chromatographed on another resin column treated with 0·12 *N* buffer *p*H 7·0, as for cow kidney. Cytochrome *c* was concentrated (the second concentrated main effluent, 0·5 ml.; R, 0·95), and crystallized in the same way as the other cytochrome *c*. The crystals were in the form of large rods (or prisms or plates), as shown in Fig. 7; the yield was about 20 mgm. from 10 kgm. of wheat germ.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Ureogenesis in Elasmobranchs

So long ago as 1858, Staedeler and Frerichs[1] discovered the presence of large amounts of urea in three species of elasmobranch fishes. Many more have been examined since that time, and it is known to-day that many, and probably all marine, elasmobranchs, including the Holocephali, contain 2–2·5 per cent of urea in their blood and tissues. Freshwater species contain only about 1 per cent of urea. The physiological significance of the resulting uræmia has been ably reviewed by Smith[2].

Despite its intrinsic interest and possible evolutionary significance, nothing is known about the biochemical mechanisms underlying ureogenesis in these fishes, and the present communication reports the results of some recent experimental studies on the problem.

In mammals, the synthesis of urea involves a number of reactions which can be conveniently summarized as follows:

(1) $CO_2 + NH_3 \xrightarrow[\text{carbamylglutamate}]{\text{ATP; } Mg^{2+}}$ carbamylphosphate,

(2) Carbamylphosphate + ornithine → citrulline,

(3) Citrulline + aspartate → argininosuccinate,

(4) Argininosuccinate → arginine,

(5) Arginine → ornithine + urea.

Reactions 1 and 2 can be studied in acetone powders prepared from well-washed suspensions of finely dispersed liver tissue. Reactions 3 and 4 can be studied in acetone powders prepared from finely dispersed but unwashed liver. Arginase, which catalyses reaction 5, is well known to be present in elasmobranch liver and, indeed, in the liver of all ureotelic animals[3].

The experiments described here were largely based upon the methods described by Grisolia[4] and Ratner[5] for rat liver; full details will be published later. Determinations of urea and citrulline were carried out by convenient modifications of Archibald's method[6]. It should be noted that adenosine triphosphate is required in reactions 1 and 3, but that the enzymes concerned are inhibited by this compound. It is convenient, therefore, to use only catalytic amounts of adenosine triphosphate, backed up by an actively glycolytic system; in the present case, phosphoglycerate was used in the presence of glycolytic enzymes prepared from elasmobranch muscle.

Reactions 3, 4 *and* 5. L-Citrulline and L-aspartate were incubated together with arginase, the glycolytic enzymes, phosphoglycerate, adenosine triphosphate and magnesium ions with extracts of the appropriate acetone powder. The usual incubation conditions were 30 min. at 30° C. in phosphate buffer at *p*H 7·3–7·4.

Urea was produced in every experiment, and typical results are shown in Table 1. 'Preformed' urea corresponds to that part of the original liver-urea not removed by the treatment with acetone.

Since argininosuccinate was not available and facilities for preparing it were not at hand, further experiments were carried out with the omission of one after another of the reactants. The results

Table 1

	Urea (μmol./gm. powder/hr.) Preformed	Incubated	Synthesized
Rhinobatus productus (1)	126	153	27
	126	178	52
,, ,, (2)	95	118	23
	95	121	26
Mustelus californicus	74	108	34
	75	103	28
Gymnura marmorata	123	145	22
	125	159	34
Urobatus halleri	126	158	32
	127	177	50

Table 2

Reactant omitted	Urea (μmol./gm. powder)	Urea formed (μmol./gm. powder/hr.)
All	75	(preformed)
None	100	+25
Citrulline	73	−2
Aspartate	78	+3
Adenosine triphosphate	83	+8
Phosphoglycerate	75	0
Arginase	100	+25

(Table 2) make it appear probable that the intermediate reactions 3 and 4 follow the same course as in the rat. It is worthy of note that arginase is clearly not a limiting factor, while the apparent slight synthesis when adenosine triphosphate was omitted is suggestive of de-inhibition.

Reaction 2. Carbamylphosphate, synthesized by the method of Jones, Spector and Lipmann[7], was incubated with L-ornithine and extracts of the appropriate acetone powder, which in this case contained no detectable amount of preformed urea. Magnesium ions and phosphate were also present, but as adenosine triphosphate is not required for this reaction it was omitted, together with phosphoglycerate and the glycolytic enzymes.

Transcarbamylation of ornithine occurred in every experiment, and some typical yields of citrulline are listed in Table 3. No citrulline was formed in the absence either of carbamylphosphate or of ornithine.

Table 3

	Citrulline formed (μmol./gm. powder/hr.
Rhinobatus productus (1)	187
,, (2)	166
Holorhinus californicus	225
Mustelus californicus	205
Gymnura marmorata	166

Reaction 1. For this reaction carbon dioxide (as bicarbonate), ammonium ions and magnesium ions are required. Traces of adenosine triphosphate are also necessary and were backed up by phosphoglycerate and the glycolytic enzymes. In addition, carbamylglutamate (or acetylglutamate) is required and acts in some little-understood manner as a catalyst. Finally, ornithine was added to react with any carbamylphosphate produced to give citrulline.

In no case was any detectable amount of citrulline formed. Undialysed and dialysed preparations were used; both acetyl- and carbamyl-glutamate were tried, and experiments were also run in the presence of versene, of cysteine and with higher and lower concentrations of magnesium ions. Attempts to fractionate the enzymes by precipitation with ethanol or with ammonium sulphate were repeatedly made but without success. Freeze-drying was no more

successful and, indeed, inactivated the enzyme responsible for reaction 2.

It is conceivable that carbamylphosphate is synthesized in the elasmobranch liver in some way that differs from that in rat liver, but it is impossible to support such a suggestion on the basis of purely negative results. It is at least equally, or even more, likely that the enzymes responsible for reaction 1 differ somewhat in their properties. It may well be that one or more of these enzymes in the elasmobranch is soluble and removed when the tissue is washed before acetone precipitation. It is possible, too, that the enzyme concerned may not yet have developed a specificity that extends to carbamyl- or to acetyl-glutamate, but might act upon unsubstituted glutamate or, perhaps, glutamine. These possibilities are being explored. Finally, if these possibilities fail to give results, it is not unlikely that more specialized preparations, for example, mitochondrial suspensions, may give results where the acetone powders have so far failed.

The work so far, then, has produced no conclusive evidence that ureogenesis in the elasmobranchs follows any pathways other than those established in the rat, and further work is in progress in the hope of elucidating the initiating reaction.

My thanks are due to Dr. Roger Revelle, director of the Scripps Institution of Oceanography, for his hospitality and facilities while this work was in progress; to the University of California for a visiting professorship; and to Miss Luellen Dale, who gave me the most valuable technical assistance.

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Intermediates in the Biosynthesis of Porphyrins from Porphobilinogen by *Rhodopseudomonas spheroides*

The formation of porphyrins[1] and of δ-aminolævulic acid[2,3] from glycine by preparations of *Rhodopseudomonas spheroides* has been reported.

Whole-cell suspensions of this organism are not capable of utilizing porphobilinogen for the synthesis of porphyrins[1]. We have found that if the cells are damaged by freezing and thawing, then porphobilinogen is converted, in 50 per cent yield, to coproporphyrin; some uroporphyrin is also formed, but this accounts for less than 2 per cent of the added porphobilinogen. It would appear, therefore, that the inability of whole cells to use porphobilinogen for porphyrin synthesis is due to the failure of that substance to enter the cells.

Acetone-dried cells also convert porphobilinogen to coproporphyrin and are more active than frozen and thawed cells on a dry-weight basis. With low concentrations of acetone-dried cells, considerable amounts of uroporphyrin III are also formed (Table 1).

Table 1. Porphyrin Formation by Acetone-dried Cells of *Rhodopseudomonas spheroides*
Acetone-dried cells in 0·4 ml. buffer pH 6·5 incubated 4 hr. at 37° with 0·1 ml. (100 μgm.) solution of porphobilinogen

Dried cells (mgm.)	Porphyrins formed (μgm.): Uro	Copro	Total
18	4	30	34
4·5	33	4	37
1·8	24	1	25

Cell-free extracts made by grinding with alumina followed by centrifugation at 12,000*g* showed weaker activity for coproporphyrin formation. Coproporphyrin was formed by high concentrations of the extract, but with lower concentrations only uroporphyrin was produced. The uroporphyrin formed under these conditions was a mixture of the I and III series isomers. Coproporphyrin-forming activity in cell-free extracts was lost on storage at −15° C., whereas acetone-dried cells and whole cells were relatively stable. Apparently the enzyme system for converting porphobilinogen to uroporphyrin is more active and more stable than that involved in the formation of coproporphyrin. The coproporphyrin formed by the three systems is mainly type III, but there is also a small amount of type I.

When the time-course of the reaction with acetone powders was followed, porphobilinogen was found to disappear very rapidly, and during the initial stages of the reaction uroporphyrin appeared to be the major product; but as the reaction proceeded, the amount of uroporphyrin present decreased while that of coproporphyrin increased (Table 2).

Table 2. Effect of Time of Incubation on Porphyrin Formation by Acetone-dried Cells of *Rhodopseudomonas spheroides*
18 mgm. acetone-dried cells in 0·4 ml. buffer pH 6·5 incubated at 37° with 0·1 ml. (80 μgm.) solution of porphobilinogen

Incubation time (min.)	Porphobilinogen used (μgm.)	Porphyrins formed: Uro (μgm.)	Copro (μgm.)	Total (μgm.)
15	31	9	6	15
30	57	16	12	28
60	80	17	24	41
120	80	9	30	39
240	80	5	30	35

Since neither added uroporphyrin I nor III was converted to coproporphyrin by acetone-dried cells, or by frozen and thawed cell preparations, it appeared that the true precursor might be uroporphyrinogen, which, becoming oxidized during isolation, would be included in the estimation of uroporphyrin. The possibility that uroporphyrinogen, or at least a reduced uroporphyrin, was an intermediate was investigated as follows. Acetone-dried cells were incubated with porphobilinogen for 1 hr. (that is, under conditions where maximum uroporphyrin appeared to be formed), and the reaction was arrested by acidifying with 5 per cent hydrochloric acid; the protein-free supernatant, after centrifuging, showed weak absorption due to porphyrin at 548 mμ and in addition an absorption band at 500 mμ. The absorption due to porphyrin increased with time, the change being accelerated by addition of hydrogen peroxide, while simultaneously the absorption at 500 mμ decreased.

When porphyrins are reduced with sodium amalgam, the typical red colour changes to yellow before the colourless porphyrinogen is finally formed. This yellow alkaline solution shows an absorption maximum at 500 mμ, which decreases as oxidation to porphyrin occurs. The intermediate reduction product is yellow in alkaline and pink in acid solution, and this compound can easily be reduced to the

Table 3. COPROPORPHYRIN FORMATION FROM UROPORPHYRINOGENS I AND III

50 mgm. acetone-dried cells in 0·4 ml. buffer *p*H 6·5 with 0·6 ml. porphyrinogen solution *p*H 6·5 containing 10^{-3} *M* sodium dithionite and 10^{-3} *M* cysteine. Controls contained porphyrinogen solution (0·6 ml.) and 0·4 ml. buffer

	Porphyrins formed: Uro (μgm.)	Copro (μgm.)	Total (μgm.)
Uroporphyrinogen I control	116	Nil	116
Uroporphyrinogen I + dried cells	8	62	70
Uroporphyrinogen III control	270	Nil	270
Uroporphyrinogen III + dried cells	19	160	179

colourless porphyrinogen with sodium dithionite. The same yellow compound is formed during re-oxidation of fully reduced porphyrinogens by air; colourless porphyrinogen solutions can be stabilized by the presence of sodium dithionite (10^{-3} *M*).

Uroporphyrinogens I and III prepared in this way and containing in addition 10^{-3} *M* cysteine to protect the enzyme from inhibition by traces of mercury were then incubated with acetone-dried cells of *Rhodopseudomonas spheroides*, whereupon large amounts of coproporphyrin were formed (Table 3). No isomerization occurred in either case; only coproporphyrin I was obtained from uroporphyrinogen I, and only coproporphyrin III from uroporphyrinogen III. The acetone-dried cells therefore contain decarboxylating systems for both the I and III series, and the final type of isomer must be determined in these preparations during the conversion of porphobilinogen to uroporphyrinogen. The isomers were identified by paper chromatography[4] and by the typical crystalline form of the coproporphyrin methyl esters. These results clearly establish uroporphyrinogens as intermediates in the biosynthesis of coproporphyrins by *Rhodopseudomonas spheroides*.

Bogorad[5,6] partially purified an enzyme from spinach which converted porphobilinogen to a colourless precursor of porphyrins. He also reported the formation of very low yields of coproporphyrin on incubating frozen and thawed *Chlorella* with uroporphyrinogens I and III[6]. Cooper[7] has studied a *Rhodopseudomonas* which produces a coproporphyrin precursor with properties akin to a coproporphyrinogen. Neve *et al.*[8] demonstrated the formation of coproporphyrin, and of hæm from uroporphyrinogen III by duck hæmolysates. Townsley and Neilands[9] produced evidence for porphyrinogen formation from δ-aminolævulic acid by cell lysates of *Micrococcus lysodeikticus*. Granick and Mauzerall[10] have shown that coproporphyrinogen III, but not coproporphyrinogen I, is a precursor of protoporphyrin in cell particulate preparations of chicken erythrocytes and of *Euglena*.

When whole cells are frozen in either buffer *p*H 6·5 or water and then afterwards separated centrifugally into a cell residue and a supernatant, an ultrafilterable co-factor for coproporphyrin formation which is stable to heat is removed in the supernatant layer. If the freezing and separation are repeated several times, and an acetone powder made of the cell residue, then this powder can convert porphobilinogen only to uroporphyrin III. Addition of either the supernatant or an acetone precipitate of the supernatant to the acetone powder of the cell residue brings about complete restoration of the ability to form coproporphyrin. The supernatant solution forms only uroporphyrin I from porphobilinogen and no coproporphyrin. Boiling completely destroys the enzyme forming uroporphyrin I. This is the first reported separation of the enzyme systems forming uroporphyrins I and III, although many reports have appeared in which the ability to form uroporphyrin III has been lost after preheating at 50–60° with the simultaneous appearance of uroporphyrin I-forming activity[11].

These results will be fully reported elsewhere.

We are grateful to Prof. C. Rimington for providing porphobilinogen and the pure uroporphyrin and coproporphyrin isomers and for his continued interest in this work.

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Glucose, Trehalose and Glycogen in *Porrocaecum decipiens* Larvæ

RECENT proof that trehalose, formerly regarded as a plant sugar, is an important constituent of a nematode, *Ascaris lumbricoides*[1], and various insects[2–4] prompted the examination of several parasitic and free-living invertebrates for this non-reducing disaccharide. Qualitative tests suggested that mature larvæ (30–45 mm.) of *Porrocaecum decipiens* (Nematoda) contained unusually large amounts. More extensive analyses were therefore performed on 108 gm. of larvæ collected from codfish muscle. Glucose and trehalose were extracted from these with several changes of cold 70 per cent ethanol. The ethanolic extracts were concentrated and washed with ether, after which trehalose was isolated[1]. The yield was 1·39 per cent of fresh tissue weight, or 6·0 per cent of the dry weight.

Two other carbohydrates were present. Glucose, determined by means of the specific glucose oxidase reaction[5], comprised only 0·6 per cent of the dry weight. Glycogen (55 per cent) was identified by its characteristic stability in alkali, insolubility in 50 per cent ethanol, and quantitative yield of glucose following acid hydrolysis. Thus, more than 60 per cent of *Porrocaecum* solids consisted of glucose residues. Lipids, as expected, were correspondingly low (3·7 per cent).

Porrocaecum larvæ live in the flesh of cod and other fishes, where they can presumably survive until presented with an opportunity to complete their development in the stomach of various seals. As the larvæ examined were in the third or fourth stage and were sheathed with the remains of the second- or third-stage cuticle, it is improbable that they were able to feed actively. It follows that the relatively enormous carbohydrate deposits are formed

in earlier stages of development, and, as the cod is a long-lived fish, serve to maintain the mature larval metabolism for long periods, or until the definitive host is reached. This supposition is supported by the observation that larvæ survive *in vitro* in 30 per cent sea water at 10°–15° C. for many weeks.

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Energy of Adenosine Triphosphate

Present knowledge of intermediary metabolism is to a large degree linked to the concept of energy transfer by so-called 'energy-rich' compounds[1] of which adenosine triphosphate is one of the most important. A wide range of values has been cited for the free-energy change on the hydrolysis of this compound at the terminal pyrophosphate group, and a brief survey of the present position may therefore be welcomed by biochemists and biologists.

In this, as in many biological reactions, complications arise from the changes of ionization in the neighbourhood of *p*H 7 and from the H^+ ion being a net reactant, as, for example, occurs at *p*H 7·5–11 :

$$ATP^{4-} + H_2O \rightarrow ADP^{3-} + HPO_4^{2-} + H^+ \quad (1)$$

The conventional standard free-energy change (ΔG^0) applies to ideal 1 *M* concentrations (the concentration of the solvent, water, is effectively unity in the solutions considered because the standard concentration is that of the pure liquid), but because this causes confusion in respect of the H^+ ion, a modified standard[2] ($\Delta G'$) is used. For this discussion, convenient standard conditions are *p*H 7·5 and ideal 1 *M* concentrations of the ions containing phosphorus of reaction 1. At other concentrations and *p*H values, the free-energy change (ΔG) is given by the formula :

$$\Delta G = \Delta G' - 2{\cdot}303\,RT\left\{p\mathrm{H} - 7{\cdot}5 - \log_{10}\frac{[ADP^{3-}]\,[HPO_4^{2-}]}{[ATP^{4-}]}\right\}$$

(At 25°, $2{\cdot}303\,RT = 1{\cdot}36$ kcal.)

An alternative set of standard conditions in common use is *p*H 7 and a total concentration of 1 *M* for all the ionic forms of each phosphate compound. The free-energy change is then 0·4–0·5 kcal. more positive than the $\Delta G'$ of this article.

Because of insufficient data, it was not at first easy to obtain even an approximate value for $\Delta G'$. Lipmann's[1] original suggestion of −9 to −11 kcal./mole is not too far from the value of −8·4 kcal., which, as discussed below, is now the most reliable one. However, a revision by Lipmann[3] and two other early estimates[4] came to about −12 kcal. Of nine later estimates or revised calculations[2,5–10], eight are between −7·4 and −10·1 kcal. and one[10] is −5·7 kcal. Several of the values are based on very inadequate data, and some large errors are now known to be present; some of the agreements appear to be the result of coincidence rather than accuracy. The more reliable values are −8·9[6], −8·3[7] (revised to −7·4[8]) and −8·0[9]. The first of these was obtained by considering a complicated series of reactions while the others were each obtained by considering a pair of reactions, namely, the glutamine synthetase reaction and the hydrolysis of glutamine or the hexokinase reaction and the hydrolysis of glucose-6-phosphate. Unfortunately, the free energies of hydrolysis of glutamine and glucose 6-phosphate were not known with the desired accuracy. The value of −5·7 kcal.[10] was also obtained from the hexokinase and glucose-6-phosphate reactions, but the equilibrium constant found for the hexokinase reaction differs by a factor of 10 from that found in the independent measurements[9] with a more highly purified enzyme.

It has recently been possible to obtain an accurate value for the free energy of hydrolysis of glutamine by using heat measurements to detect and measure the reversibility of the enzyme-catalysed hydrolysis[11,12] and applying measured values[13] for the activity coefficients of ammonium glutamate. When taken with the data for the adenosine triphosphate coupled synthesis of glutamine[7] (corrected for the binding of the nucleotides by Mg^{++} ion)[14], the free energy of hydrolysis of adenosine triphosphate is found to be −8·4 kcal.[12]. The conformity with the more reliable of the earlier estimates indicates that there is now a considerable body of reasonably consistent free-energy data for intermediary metabolism.

Measurements of the heat of hydrolysis in the presence of purified myosin adenosine triphosphatase have given values of −4·7 and −4·8 kcal.[15]. The separation of like ionic charges in the reaction should make a considerable positive contribution to the entropy change and thus the newer ΔH values are more consistent with the free-energy data than are the earlier ΔH values of −12 kcal.[16].

The calculation of free-energy data for physiological conditions is complicated by the probable dependence of intracellular concentrations on the metabolic state, by the concentration gradients between the primary sites of phosphorylation and other parts of the cell, and by the possibilities for extensive binding of compounds of low molecular weight to other components of the cell. Thus, although the concentrations of adenosine tri- and di-phosphate and inorganic phosphate found in whole tissues suggest that, in living cells, the free energy of hydrolysis of the triphosphate is 11–12 kcal., this figure is not sufficiently reliable to decide with confidence what proportion of metabolic energy is, in fact, transferred to it. It is, however, possible to obtain a more satisfactory estimate of the proportion of energy transferred to adenosine triphosphate during oxidative phosphorylation by tissue suspensions and mitochondrial preparation. Under the conditions of these *in vitro* studies[17], ΔG for the hydrolysis of adenosine triphosphate is evaluated as about −12·5 kcal. and the results indicate an efficiency of about 70 per cent. Thus, so far as it is at present possible to interpret them, the thermodynamic data are in accord with the present concept that nucleoside triphosphates play a central part in the energy transformations of living matter.

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Effect of Caffeine and Other Purines upon the Ribonucleic Acid/Deoxyribonucleic Acid Ratio in Leaves, and the Suitability of these Leaves for Aphids

THE proportion of cytoplasm to nucleus is reported to increase with age[1]; in our preliminary work a corresponding increase was found in the ribonucleic acid/deoxyribonucleic acid ratio. Since aphids usually prefer young leaves[2], it was thought of interest to investigate the relation between changes in this ratio with ageing of the leaves, and their suitability as food for aphids. For this purpose the synthesis of nucleic acids in leaves was experimentally induced or inhibited by various agents[3,4]. Aphid populations were counted at various intervals after treatment and leaves were analysed for ribo- and deoxyribo-nucleic acids.

One-year-old apple trees of the Hashabi variety were used. Young apple leaves, at about ¼–⅓ of their final size, were sprayed with 25, 50 and 100 p.p.m. solutions of caffeine in water. The experiments were done in triplicate. Twenty days after treatment young leaves were collected and analysed for ribonucleic acid[3] and deoxyribonucleic acid[4]. For comparison, young, mature and senescent leaves were also analysed. It is seen from Table 1 that with increasing concentrations of caffeine the ratio considerably increases, while the absolute level of deoxyribonucleic acid decreases. Similar changes occurred during the natural development and ageing of leaves.

The same apple trees were also used for the aphid experiments. On the eighth day after treatment the upper 7–8 leaves of each plant were infested with young larvæ (3 × 50) of apple aphids (*Aphis pomi* Deg.) which were kept in a large linen cage. Aphid populations in the cage were counted regularly. Eighteen days after treatment the plants were thoroughly cleaned of all aphids and treated leaves from new branches were infested with 50 aphids per plant. Table 2 summarizes a typical experiment, showing that for the first infestation the increase in aphid population was approximately inversely proportional to the caffeine concentration, the highest increase being in the untreated control. During the second infestation the same trend was observed. During the latter part of the experiment sexuales began to appear, and since these react differently, from viviparae to the ageing of leaves[5], the experiment was discontinued. No such effects were obtained with adenine.

Table 1. THE RIBONUCLEIC/DEOXYRIBONUCLEIC ACID RATIO IN YOUNG, MATURE AND SENESCENT APPLE LEAVES, AND THE EFFECT OF CAFFEINE CONCENTRATION ON THE NUCLEIC ACID FRACTIONS

Phase of leaf development		Ribonucleic acid*	Deoxyribonucleic acid*	Ribonucleic acid/deoxyribonucleic acid
Young		0·385	0·240	1·6
Mature		0·442	0·191	2·3
Senescent		0·217	0·104	2·1
External caffeine concentration (p.p.m.)	0	0·410	0·261	1·6
	25	0·532	0·196	2·7
	50	0·614	0·187	3·3
	100	0·680	0·125	5·4

* Percentage of dry matter

Table 2. EFFECT OF CAFFEINE TREATMENT ON APPLE-APHID INFESTATION ON APPLE LEAVES (NO. OF APHIDS ON BRANCHES IN CAGES)

Treatment	Days after treatment									
	8*	13	15	19†	19‡	20	24	26	28	35
Control	150	500	850	1,260	150	109	142	256	266	705
Caffeine:										
25 p.p.m.	150	452	680	995	150	98	126	92	102	257
50 p.p.m.	150	152	351	451	150	115	147	120	124	380
100 p.p.m.	150	10	15	17	150	88	67	54	46	156

* Leaves infested on eighth day with 150 aphids.
† Leaves cleaned of aphids on nineteenth day.
‡ Other treated leaves infested on nineteenth day with 150 aphids.

Similar results were obtained on populations of *Aphis craccivora* Koch when bean leaves were treated with caffeine or xanthine. Again, populations decreased considerably after both treatments as compared with the control.

In order to determine whether this toxic effect of caffeine was due to direct contact with the aphids, apple aphids were exposed in Petri dishes to known amounts of caffeine residues for 4 hr. They were then transferred to young apple leaves and mortality was counted after 24 hr. It was shown that caffeine, at a concentration of 900 μgm./cm.², did not kill an appreciable number. Since leaves sprayed with 100 p.p.m. of caffeine had a maximum deposit of only 0·7 μgm./cm.², the toxic effect of caffeine cannot have been caused by direct contact. This conclusion is supported by the experimental observations that solutions of caffeine (in chloroform), applied topically, killed houseflies only at extremely high dosages. On the other hand, the possibility that caffeine is absorbed into the plant juice, and hence affects the aphids as a stomach poison, cannot be excluded. To investigate this point the caffeine fraction which penetrated the leaves was analysed[6]. Before analysis the leaves were first carefully washed with acidified distilled water, then with hot water at 60° C., and finally five times with glass-distilled water. Leaves sprayed with a 100 p.p.m. caffeine solution, 10 days after treatment, contained not more than 0·04 μgm./cm.² (or 1·6 μgm./gm. fresh matter) of caffeine. In comparative tests with houseflies kept for 24 hr. on sugar and a 7 mgm./c.c. caffeine solution in water, no mortality was observed for 72 hr. This indicates

that caffeine at the concentration employed apparently does not act as a stomach poison against insects.

From these and other experiments it is apparent that the ribonucleic acid/deoxyribonucleic acid ratio increases with age and that variation can be induced experimentally, for example, by the addition of caffeine, which inhibited the synthesis of deoxyribonucleic acid considerably and promoted that of ribonucleic acid. In this respect it was found that caffeine affects only young leaves, where cell division probably still occurs.

This resemblance between natural changes and those induced by caffeine is reflected in our results with aphids, which developed to a much lesser extent on mature[7] and on leaves pretreated with caffeine. The results reported in this communication lead us to the assumption that the effect of caffeine on aphids is brought about by induced metabolic changes in the leaf, which resemble those found in maturing leaves. It is suggested that caffeine interferes with developmental reactions of the leaf, and it seems that nucleic acids play an important part in these reactions. Our results further demonstrate intimate relations which apparently exist between the physiology of a host plant and its parasite.

A full account of this work will be published elsewhere.

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Oxidation Products of Leuco-anthocyanins as Inhibitors of Fungal Polygalacturonase in Rotting Apple Fruit

Sclerotinia fructigena Aderh. and Ruhl. causes a firm, brown rot of apple fruit. When the fungus is grown in a synthetic medium, active polygalacturonase and pectin-methylesterase can be detected in the culture filtrate. However, examination of Bramley's Seedling apples rotted by the fungus revealed that although the total pectic substances of the tissue insoluble in water had been reduced by 10 per cent and a small amount of galacturonic acid formed, only a trace of polygalacturonase activity could be detected; pectin-methylesterase activity was found. An explanation for the absence of polygalacturonase activity in rotted tissue was sought.

Cole[1] found evidence that apple juice could reduce the activity of the polygalacturonase of *S. fructigena*, measured by its power to macerate and to reduce the viscosity of pectate, and Byrde[2] found that the oxidized (browned) juice of certain high-tannin varieties of apples resistant to *S. fructigena* reduced the first of these but not the second. Several workers have demonstrated partial inhibition of other fungal or bacterial enzymes, which macerate and degrade pectin, by various kinds of plant extracts[1,3,4]. Tannic acid[4], tannin[5] and gallotannin[3] have also been shown to be partially inhibitory.

An examination of the polyphenolic constituents of apple fruit was made to see if any of them, in the unoxidized or oxidized state, could act as inhibitors of *S. fructigena* polygalacturonase. Polyphenolic compounds in ethanolic extracts of Bramley's Seedling apples, both healthy and those rotted by *S. fructigena*, were examined by two-way paper chromatography. Chlorogenic acid, catechin, epicatechin, leuco-anthocyanins, suspected *p*-coumarylquinic acid and traces of unidentified phenolic compounds were detected in healthy apples. These compounds have already been recognized in apple juices and ciders[6]. The paper chromatograms of rotted tissue showed the disappearance of catechins and the leuco-anthocyanins with a high R_F value, reduction in quantity of the leuco-anthocyanins with a lower R_F value and chlorogenic acid, and the appearance of several new spots. Quantitative analyses of the alcoholic extracts of rotted tissue in comparison with healthy tissue showed reductions of 79 per cent in total phenolics[7] (Folin and Denis reagent), 88 per cent in flavans[7] (acid vanillin reagent), 89 per cent in leuco-anthocyanins[7] (acid butanol reagent) and 88 per cent in chlorogenic acid (two-way paper chromatographic separation using Whatman 20 paper and the top layer of *n*-butanol/acetic acid/water, 4 : 1 : 5 (v/v/v), in the first direction, and 2 per cent v/v acetic acid in the second; fluorescent spots were eluted with water and the light absorption measured at 325 mμ).

There were thus considerable losses of phenolic compounds during rotting, in most cases probably through oxidative polymerization to brown compounds insoluble in the solvents used for extraction. Tests were made on the oxidized and unoxidized forms of the major phenolic constituents of sound apple fruit to see if they were inhibitory to the polygalacturonase of *S. fructigena*. Chlorogenic acid and *d*-catechin (both from L. Light and Co., Ltd.) were not inhibitory, even after oxidation to brown solutions with the polyphenoloxidase of *S. fructigena*. Bramley's Seedling apples were extracted to obtain samples of other polyphenolic constituents using the method of Roberts, Cartwright and Wood[8] but excluding the column separation stage. Samples of four fractions thus obtained were evaporated to dryness, dissolved in water and added to filtrates of *S. fructigena* cultures known to contain polygalacturonase and polyphenoloxidase, with or without the inclusion of sodium cyanide at a final concentration of 0·05 per cent w/v. As a control, water was used in place of the phenolic fraction. The reaction mixtures were kept for 10–12 hr. at room temperature before their polygalacturonase activities were determined by a viscometric method[9] (Table 1). At the end of this time all the reaction mixtures which did not contain cyanide were deeper brown than at the start, with the exception of the one containing fraction 3, which was already brown at the start. Those containing sodium cyanide did not change colour. With the reaction mixtures in which greatest reduction of polygalacturonase activity was found, paper chromatography revealed a considerable reduction in the formation of galacturonic acid and intermediates from the breakdown of pectate.

From the above results it would seem that only the leucoanthocyanins can act as precursors of the inhibition of polygalacturonase; that is, they act as inhibitors only after they have undergone what is possibly a

Table 1. POLYGALACTURONASE ACTIVITY OF CULTURE FILTRATES STORED WITH EXTRACTS OF PHENOLIC CONSTITUENTS. (SODIUM AMMONIUM PECTATE BUFFERED AT *p*H 5 WITH CITRATE WAS USED AS SUBSTRATE)

Phenolic fraction	Polyphenolic compounds present in fractions	Presence (+) or absence (−) of sodium cyanide	Polygalacturonase activity* after 10–12 hr. treatment with phenolic fraction
Fraction 1	*A*, *B*	−	18
		+	19
Fraction 2	*A*, *B*, *C*, *D*	−	5†
		+	17
Fraction 3	*A* (trace), *D*, *E*	−	3†
		+	8
Fraction 4	*A*, *B* (trace), *C*, *D*	−	2†
		+	11
Water	−	−	19
		+	19

A, Chlorogenic acid; *B*, suspected *p*-coumarylquinic acid; *C*, catechins; *D*, leuco-anthocyanins with R_F 0·4–0·1 (*n*-butanol/acetic acid/water (4 : 1 : 5) by vol., upper layer, Whatman No. 1, 20° C.; *E*, leuco-anthocyanins with R_F 0·1–0 (same solvent, etc.).

* Activity expressed as $100/t$, where t is time (min.) for 50 per cent loss in viscosity.

† Approximate.

quinone polymerization similar to that described by Hathway and Seakins[10] for the catechins. Fraction 3 contained a leuco-anthocyanin of low R_F which was partially inhibitory even in the presence of cyanide. By inhibiting the polyphenoloxidase of the culture filtrate, the cyanide prevented the formation of oxidized and polymerized leuco-anthocyanin.

These results suggest the following explanation for the fact that the rots of apple caused by *S. fructigena* are firm, brown and contain no polygalacturonase. The fungus secretes this enzyme, which starts to attack the pectic materials of the host tissue; the fungus also produces polyphenoloxidase which, with the same enzyme from the host, oxidizes the leuco-anthocyanins to a polymer which inhibits the polygalacturonase, possibly by a tanning action[11], before it has time to macerate the tissue with the production of a soft rot. The oxidation of the leuco-anthocyanins, catechins and other compounds causes the brown coloration. It has recently been reported[12] that the pectin-methylesterase of tea is partially inhibited by tea catechins and their oxidation products; however, because of the high pectin-methylesterase activity of *S. fructigena* rots, it seems unlikely that this is significant in apples.

A detailed account concerning several fungi will be published elsewhere. I should like to thank Drs. A. C. Hulme and R. K. S. Wood for their help and encouragement, and the Department of Scientific and Industrial Research for a research studentship.

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Division of a Nucleus lacking a Nucleolus

IT has been suggested from McLeish's cytological studies of the broad bean, *Vicia faba*, that a nucleus lacking a nucleolus cannot reproduce[1]. Similarly, Gaulden and Perry[2] have shown that mitosis in the grasshopper neuroblast is permanently inhibited when one of two nucleoli is irradiated with an ultraviolet microbeam. The attached X attached XY system ($\overline{XX}$, $\overline{XY}$) constructed by Lindsley and Novitski[3] in *Drosophila* provides an opportunity for investigating in another organism the behaviour of a nucleus that is deprived of a nucleolus. Nucleolus organizer regions exist on both the X and Y chromosomes of *Drosophila*, and none exists on the autosomes. When an $\overline{XX}$ female is crossed to an $\overline{XY}$ male, four types of zygotes are obtained, each containing the complete set of autosomes, but varying in sex chromosome constitution. With respect to the sex chromosomes, the zygotes are $\overline{XX}/O$, $\overline{XY}/O$, $\overline{XX}/\overline{XY}$, and O/O, where O represents the absence of a sex chromosome. The $\overline{XX}/O$ become normal females, the $\overline{XY}/O$ become normal males, the $\overline{XX}/\overline{XY}$ become superfemales, and the O/O die during embryogenesis. Hence, 25 per cent of the total embryos should be O/O in character.

The dead (non-hatching) embryos from $\overline{XX}/O$ crossed with $\overline{XY}/O$ were examined cytologically and the time of death determined. Only the dead embryos of pair matings that had higher than 50 per cent hatchability were studied in order that the frequency of unfertilized eggs be minimal. Hatchability of Oregon-*R* controls was 94·4 per cent. The results are shown in Table 1. 183 of the 564 embryos did not hatch; 13 per cent of the dead embryos were lost during fixation and staining. The majority of embryos died after about 10–12 nuclear divisions (approximately 1,000–4,000 nuclei are present), but before blastula formation. These are regarded as representing the O/O (non-nucleolar) class, since when corrected for those lost during fixation and staining (assuming random loss from each class) they constitute 21·6 per cent of the total eggs. The 43 embryos dying during late embryogeny are probably from the $\overline{XX}/\overline{XY}$ class since superfemales have high mortality expressed presumably at several stages of development. The ten embryos that died during very early embryogeny remain unaccounted for, but they may be unfertilized eggs; these embryos with little or no visible chromatin represent about 2 per cent of the total eggs laid.

In the *Drosophila* embryonic system, it is therefore evident that a nucleus deprived of a nucleolus can undergo several divisions. Even the eventual death cannot be ascribed to the absence of the nucleolus since many of the dead embryos of the 1,000–4,000 nuclei class, superficially at least, resemble the embryos studied by Poulson[4] that lack an X chromo-

Table 1. HATCHABILITY AND TIME OF DEATH OF DEAD EMBRYOS FROM CROSS OF ATTACHED *X* FEMALE WITH ATTACHED *XY* MALE

Viable embryos/Total	Dead embryos			
	No chromatin visible	1,000–4,000 nuclei	Later embryogeny	Lost during fixation and staining procedures
381/564	10	106	43	24

some but contain a *Y* chromosome with its associated nucleolus. Since products necessary for chromosome reduplication are already deposited in insect embryo cytoplasm[5,6] it may be that normal nucleolar function is also unnecessary during early embryogeny. In this respect, it is noteworthy that nucleoli usually do not develop during interphase of the rapid mitoses of early development. Hence, extreme caution should be exercised in interpreting nucleolar function from the particular case presented here. On the other hand, it is clear that at least 10–12 mitoses can occur in the *Drosophila* embryo when the zygote nucleus is devoid of a nucleolus.

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* Operated by Union Carbide Corporation for the U.S. Atomic Energy Commission.

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A Mammalian Activity Rhythm independent of Temperature

One of the most important characteristics of biological rhythms is their independence of temperature. Even the mammal may display a wide range of body temperatures, so that any hypothetical biochemical clock that it may possess may be 'challenged' to measure time at low temperatures. Some mammals have a wide range of body temperature both in a warm environment and while going into hibernation. Furthermore, with hypothermia as a procedure in human surgery, even human subjects undergo large changes in body temperature. Thus, measurements of rhythms in the cold mammal are of increasing interest. The following preliminary notes suggest the independence of temperature of a mammalian activity rhythm.

We have reported evidence for regularity in periodic awakening of ground squirrels from hibernation as follows: (1) hamsters and ground squirrels were maintained all summer at control temperatures with a daily cycle of 12 hr. of artificial light and 12 hr. of darkness; (2) they were then permitted to hibernate for four months in a cold chamber (6 ± 1° C.) with a light cycle (7 foot-candles); (3) the awakenings of the hamsters were at random (50 per cent, at the time of the original light cycle), but the ground squirrels awoke 72 per cent of the time during the periods corresponding to the original light cycle[1]. New evidence is reported here, obtained from a second winter of observations on the same ground squirrels. The animals were illuminated in the cold room daily from 9 a.m. to 9 p.m. and only at these times were observations made. All eleven animals hibernated intermittently for four months, awakening after intervals of dormancy lasting from one to eighteen days; 164 periods of dormancy were observed. Again for the second season more squirrels (63 per cent) awoke from the dormant condition when the light was on (results statistically significant). In most cases the squirrels went into hibernation in darkness (57 per cent). Interpretation must interrelate the following five points: (1) mammals in hibernation appear to be blind[2], and once ground squirrels begin to awaken from hibernation they do not interrupt the process and return to the dormant condition until they have remained fully active for at least 12 hr.[3]; (2) ground squirrels have a distinct 24-hr. activity rhythm just before going into hibernation; (3) they are apt to enter into hibernation in dark periods (of minor importance in the present interpretation); (4) most individuals awaken from hibernation in illuminated periods; (5) they show variable periods of dormancy (1–18 days). This combination of observations can best be understood by postulating a clock, independent of temperature, controlling the state of the animal in hibernation. The best hypothesis seems to be that there are regular periods of shallow and deep hibernation, perhaps of about 12 hr. each. When either the light cycle or endogenous stimuli responsible for awakening (hunger, full bladder, etc.) coincide with the shallow phase, the animal may awaken. These interpretations are being tested experimentally.

The ecological significance of a clock independent of temperature in hibernation can be illustrated by the important rule that the rodent 24-hr. rhythm (which can be represented as a dial of behaviour sequences) can be reversed or 'turned' by 12 hr. only by a gradual process taking at least four days[4]. Thus, if a free ground squirrel, which is a day-active species, were to awaken at night from hibernation in the spring, it would probably be incapable of causing its behaviour sequence to jump the gap to the day period until several days had elapsed. Apparently this could be avoided by the independence of temperature of the biological clock during hibernation.

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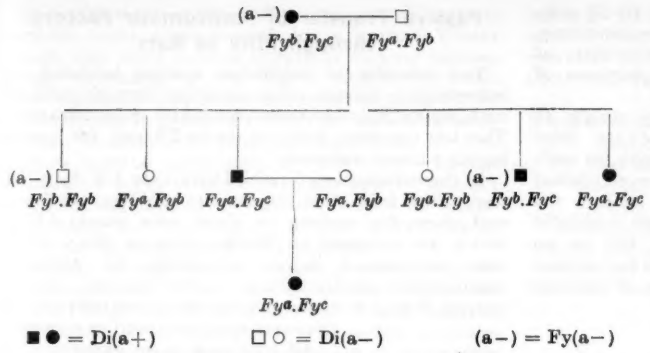
Diego as an Independent Blood-Group System

It has been repeatedly found that a blood-group antigen thought to be a part of a 'new' blood-group system is in fact part of an old one; Tj^a is now part of the *P* system; U, V^w and Mi^a of the *MNSs* system. Concerning the more recently reported 'new' antigen Di^a, publications up to, and including, that of Levine and Robinson[1] have shown its inheritance to be independent of the genes of the *ABO*, *MNSs*, *P*, *Rh*, Lewis and Kidd systems, and that it is not identical with any of six previously described antigens of low frequency, Ven, Ca, Be^a, Wr^a, By^a and Rm. That it is not part of the Duffy or Kell system has not been proved.

As part of a study of blood-group genes of a Japanese population in Canada, we recently published[2] the blood groups, so far as we were able to carry



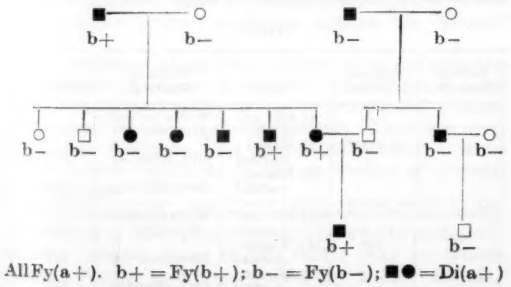
Pedigree 1. The original Diego family tested with anti-Di^a and anti-Fy^a but not anti-Fy^b; theoretical interpretation if *Di^a* were a third allele of Duffy, *Fy^c*

them at that time, from a large sibship in which *Di^a* occurred. This confirmed Levine and Robinson's findings so far as lack of any close linkage between *Di^a* and *ABO*, *MNSs*, *P*, *Rh* and Lewis are concerned, but still left open the possibility that *Di^a* might be part of the Duffy or the Kell system. We now have further facts about the two systems.

Duffy. The original Diego family is one of mixed blood, certainly part White and part Indian and possibly part Negro. Sanger, Race and Jack[3] proved that a high percentage of Negroes do not react to either anti-Fy^a or anti-Fy^b; therefore they either have alleles of the Duffy system other than *Fy^a* and *Fy^b*, or no representation of the Duffy locus. From this it follows that if the Diego family carry Negro genes, it might have a third allele of Duffy, and this allele might have been characterized as '*Di^a*'. Assuming a third allele of Duffy and calling it *Fy* , Levine and Robinson's study of that family, using only anti-Fy^a and Di^a, could be interpreted as indicated in pedigree 1 (only those members of the sibship tested with both anti-Di^a and anti-Fy^a are shown).

However, the following facts suggest that this is not so. The family we reported[2] is pure-blood Japanese. We have now tested the family with a serum containing anti-Fy^b. (The presence of anti-Fy^b was verified in both Drs. Race and Sanger's laboratory and that of Dr. Amos Cahan.) The results, so far as they are pertinent, are set out in pedigree 2.

It is evident that *Di^a* segregates independently of *Fy^a* and *Fy^b*. *Di^a* is not a third allele of the Duffy locus, or an antigen linked to *Fy^a* or *Fy^b* as *S* and *s* are to *M* and *N*.



Pedigree 2. Japanese family tested with anti-Di^a, anti-Fy^a and anti-Fy^b, proving that segregation of Di^a is independent of the Duffy system. All members Fy(a+)

Kell. The situation as regards Kell remains uncertain. All the members of the Diego family tested were negative to anti-K. (It is not evident from Levine and Robinson's report[1] whether they were tested with anti-k.) All the Japanese we have tested have been negative to anti-K and, where tested, positive to anti-k. This, however, does not prove that they are of genotype *kk*. If *Di^a* were an allele of the Kell locus, which we might call *k^d*, a person of phenotype K−, k+, Di(a+) could have the genotype *k^{d}k*. Equally, *Di^a* could be a gene linked to *k* or *K* as *S* and *s* are to *M* and *N*. That *Di^a* is not identical with *Kp^a* we have been able to prove by testing twelve members of pedigree 2, four of them Di(a+), with anti-Kp^a; they were all negative. All twelve are Kp(b+). Proof that *Di^a* is not an allele at the Kell locus will be difficult. It will depend upon finding a family in which the phenotype K+ Di(a+) or homozygous *Di^a.Di^a* occurs. If *Di^a* is an allele at the Kell locus then in the first case such a person should be k−, and in the second K− k−; if they are not, then *Di^a* is not an allele of Kell, although it could still be an associated or linked gene as *S* and *s* are to *M* and *N*. (The phenotype K− k− in itself says nothing about relationship between *Di^a* and the Kell system; the two K− k− sisters we recently reported[2] are Di(a−).)

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Heat Output and Body-weight in the Growing Albino Mouse

Although numerous measurements have been made of the metabolic rate of mice in the basal state[1,2], it was felt that for many purposes values of the heat output of mice in a normal laboratory condition would be more useful. In the course of determining this quantity, a series of measurements was made on mice from weaning to maturity. The results obtained were unexpected, and, since no similar work can be found in the literature, it is believed that they are worth reporting.

The differential calorimeter described by Clarke and Hawkins[3] was used to determine the heat outputs of seventeen litters of albino mice. The mice lived in an ambient temperature of about 18° C. with free access to food and water. The ambient temperature in the calorimeter during measurements was in the zone of thermal neutrality (28–34° C.).

A total of approximately three hundred runs was made during which some eighty mice were used. Each run was made with the mouse in the apparatus for 30 min., readings of the heat output being

obtained every 0·5 min. during the last 20–25 min. The activity of the mouse was noted at the same time, there being several recognizable levels of activity of which the 'still' state is the best for purposes of comparison.

The mice were divided into groups by weight at 1-gram intervals and the readings of the heat output when the mice were 'still' averaged for each group. Following Kleiber[4], these results were plotted as the logarithm of the heat output against the logarithm of the weight. This was done originally for male and female mice separately, but as no difference could be detected in the graphs for the two sexes, the results for all mice, regardless of sex, are shown in Fig. 1.

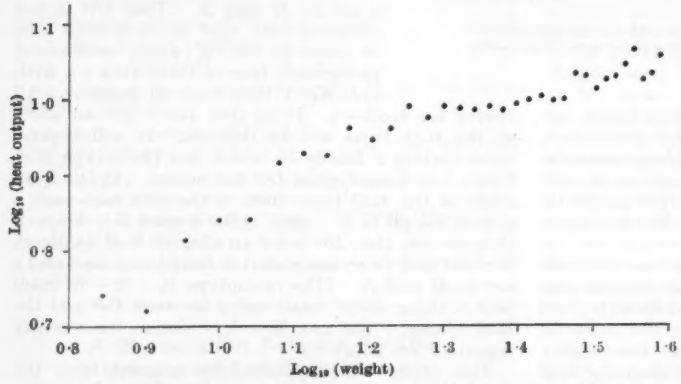

Fig. 1. $\log_{10}$ (heat output) plotted against $\log_{10}$ (weight) for albino mice in the 'still' state. Heat output in Cal. day^{-1}, weight in gm.

A change in the relation occurs in the region $\log_{10}$(weight) = 1·20–1·30, that is, in the age-range 30–40 days. The experimental points suggest that in this region a straight line of the expected slope[4] of 0·75 changes to a straight line of negligible gradient. There is an indication that in the neighbourhood of $\log_{10}$(weight) = 1·45 (age 60 days) the original slope is re-established, but this is too near the maximum weight attained by the mice for any definite conclusion to be drawn.

To confirm that the curves were characteristic of the mice and not of the apparatus, an electric heating coil was substituted for the mouse in the animal chamber.

A possible explanation for the change in the relation between the heat output and the body-weight at the age concerned may be the sex factor. The results of Parkes[5] and of Engle and Rosasco[6] show that albino mice attain sexual maturity at about this age.

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Passive Transfer of Antitumour Factors through Milk in Rats

The transfer of antibodies against bacterial or heterologous normal tissue antigens through milk to suckling animals has been repeatedly demonstrated[1]. This has not been done, so far as I know, for homologous tumour antigens.

In the experiments reported here, rats 1–2 days old were taken from their normal albino Wistar mothers, and given for nursing to black rats (strain *bWr*), which are resistant to Walker tumour 256; these were immunized before pregnancy by repeated unsuccessful implantations of the tumour. Other normal Wistar mothers, nursing their own offspring of the same age, were used as controls.

All sucklings in an experimental group were inoculated, subcutaneously in the suprascapular region, with equal, relatively low doses of live tumour cells (200,000 or 100,000) in 0·1 ml. saline. Precautions were taken to ensure the strictest possible equality of the doses in every litter in a given experiment, by shaking the suspension in the container and in the syringe, and by inoculating rats from each of the three litters in turn. In all experiments of this kind normal Wistar sucklings were, to a certain extent, protected against the growth of the tumour inoculum by the milk of the immune *bWr* nurse. The differences between individual experimental sets in the degree of protection can most probably be explained by quantitative variations, for example, the number of tumour cells used or differences in the immune state (titre) of the *bWr* nurses.

As an example, results of two such experimental sets are summarized in Table 1.

With the doses used, no new tumours appeared, as a rule, after the twentieth day following inoculation, which was performed on the second or third day of life. First tumours usually appeared from the tenth day onward. Deaths of young animals with tumours occurred regularly in the 7–10 days following. Occasionally, a Wistar or a *bWr* suckling, either protected or unprotected by the intake of immune milk, died from rapidly developing lung metastases of the tumour, even when the primary tumour at the site of implantation was very small or invisible. Here a direct inoculation of tumour cells into the blood stream of the suckling may be suspected.

Table 1

Experiment No.	Tumour cell dose	Nurse	Strain of sucklings	Tumours*
1	2×10^5	(*a*) *bWr* immune	Wistar normal, from (*b*)	5/11
		(*b*) Wistar normal	*bWr*, from (*a*)	3/7
		(*c*) Wistar normal	Own offspring	9/9
2	10^5	(*a*) *bWr* immune	Wistar normal, from (*b*)	0/7
		(*b*) Wistar normal	*bWr*, from (*a*)	0/7
		(*c*) Wistar normal	Own offspring	8/8

* Ratio of the number of sucklings showing palpable tumours on the twentieth day from implantation to the total number of the litter.

The offspring of the *bWr* immune or normal mothers, even when nursed by a normal Wistar female, may resist tumour growth in varying degrees, usually depending on the dose of tumour cell used. Their resistance may be explained most plausibly by the relatively long lag in tumour growth with small inocula, so that the young *bWr* rats have time to produce tumour antibodies of their own. In the offspring of immune mothers, some passive transfer of antitumour factors by way of placenta, or intake of immune milk (colostrum) in the short interval before the exchange cannot be excluded.

Another experiment, on 'double passive transfer', was undertaken. The offspring, all born within an interval of 36 hr., of three normal Wistar females, were inoculated simultaneously with a dose of about 250,000 live tumour cells each, and left to nurse with their own mothers. One of these mothers was injected intraperitoneally, after delivery, with relatively large doses of immune rat serum (4 ml. every third day, about 20 ml. altogether); the second mother rat was injected with the same dose of normal rat serum, and the third was left untreated. The immune serum was taken, this time, not from *bWr* immune rats, but from resistant Wistar rats, which can be selected from our commercial stock.

On the eighteenth day after tumour inoculation, the following proportions of palpable tumours appeared. (*a*) Mother treated with immune serum: 3/9. (*b*) Mother treated with normal serum: 9/9. (*c*) Untreated mother: 8/9.

It appears here that the antitumour factors from the immune serum injections, though diluted by the metabolic stream of the recipient mother, are still effective in tumour inhibition in the sucklings. But conditions were different: the tumour dose was relatively high; the last serum injection to the mother was done on the ninth day after tumour inoculation, so that by the eighteenth day its effect may have been exhausted; lastly, the milk proteins and antibodies are more thoroughly digested by the maturing enzymes of the sucklings (*a*). Therefore, during the following 10 days, tumours also appeared in all but one of the sucklings in the protected litter, so that the protection was manifested here only by a postponement of tumour growth.

Besides these, a 'feeding experiment' was also undertaken. Sucklings nursed by their own normal Wistar mother were given daily, by means of a pipette, some drops of either immune or normal rat serum by mouth. Here, too, there was an indication of protection against tumour growth.

In the experiments on 'milk protection' it was noted repeatedly that a normal (non-immune) *bWr* nurse cannot protect sucklings against the tumour growth.

The results of these experiments agree remarkably with results of passive transfer of antitumour factors by serum injections[2,3], or by injections of culture media from tumour-immune spleens[4]. They are very persuasive evidence that these antitumour factors circulate, very much as do the antibodies of current immunology.

Participation of a general transplantation immunity component in these results cannot be wholly excluded, but the relative share of this factor may be rather small: Wistar sucklings nursed by a *bWr* female, immunized by a tumour of Wistar origin, grew normally, and only their tumour growths were inhibited. The influence of this anti-strain effect of immune serum may be even less in the double transfer experiment, where immune serum of Wistar rats was injected into Wistar females nursing their own offspring.

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Adverse Effect of Nitrate Metabolic Products on Sheep Growth

It has been found that the metabolism of nitrate in the rumen of the sheep on pasture can induce marked changes in the molecular percentage structure of the rumen volatile fatty acids. These changes consisted in a lowering of the percentage of acetic acid with a compensating increase in those of propionic and butyric acids. The composition of the volatile fatty acids of the rumen was determined by gas-liquid chromatography[1].

Rumen samples of similar volatile fatty-acid composition had been frequently recorded from sheep on ryegrass – clover pasture. Animals showing these low percentages of acetic acid tended to be making poor growth about the time of sampling. The nitrate content of the pasture was variable, and covered the range 0·18–9·28 gm. potassium nitrate/100 gm. dry matter.

The investigations of Lewis[2] suggest that the sequence, nitrate → nitrite → hydroxylamine → ammonia, long postulated in the chemistry of nitrate assimilation on the part of plants and micro-organisms[3], occurs in the rumen. These nitrate-reduction products have been examined for their influence on the volatile fatty acids of the rumen and for their effect on sheep growth.

Table 1 shows the effect of dosing nitrate, nitrite and hydroxylamine on the molecular percentage structure of the rumen volatile fatty acids of the sheep on grass. The change obtained with nitrate persisted over the period of dosing, whereas that associated with nitrite was transient and a return to the original percentage of acetic acid occurred during dosing. Hydroxylamine produced no significant effect.

An additional finding of considerable interest was the fact that hydroxylamine and certain oximes in comparatively small amounts caused a severe hæmolytic anæmia in sheep after oral or intravenous administration.

Oral doses of 40–80 mgm./kgm., and intravenous doses of 1–7 mgm./kgm. body-weight of hydroxylamine hydrochloride brought about a lowering of the hæmatocrit readings within twelve to fifteen days from the normal range of 30–40 per cent to values as low as 10–20 per cent. The serum contained hæmoglobin at the third to fifth day after dosing, and some animals exhibited hæmoglobinuria just after this stage. These results extend to the sheep the finding of Emerson, Ham and Castle[4] of hæmolytic activity on the part of hydroxylamine in the cat and rabbit. An apparently similar hæmolytic anæmia in sheep has been found to occur spontaneously in

Table 1. Changes produced in the Volatile Fatty Acid Composition of Rumen Liquor from Sheep on Pasture during the Metabolism of Nitrate and its Reduction Products

Condition of sheep	pH of rumen contents	Total volatile fatty acids (m.mole/100 ml.)	Molecular percentages of individual fatty acids							
			Formic	Acetic	Propionic	*iso*Butyric	*n*-Butyric	*iso*Valeric	α-Methyl-butyric	*n*-Valeric
Control sheep	6·7	7·5	0	57·5	22·5	2·5	13	1·5	1·5	1·5
Nitrate dosed	6·5	7·1	0·5	41·5	35·5	3	15·5	1	1	2
Nitrite dosed	6·6	6·9	1·0	42	36·5	2·5	14	1	1	2
Hydroxylamine dosed	6·8	7·7	0	57	23	2	13·5	2	1·5	1

normal untreated experimental animals grazing ryegrass – clover pasture.

The presence of hydroxylamine in the rumen of the normal sheep on pasture, and at higher concentrations up to 300 μgm./100 ml. in the rumen metabolizing added nitrite, has been detected and estimated by the Endres method as used by Novak and Wilson[5].

It has been possible to show that if a hæmolytic anæmia induced by hydroxylamine in the sheep was prolonged by repeated intravenous doses, a highly significant decrease in growth relative to non-anæmic control animals grazing the same pasture occurred. From an initial mean live-weight of 70 lb., the anæmic animals in 49 days lost 2·25 lb., while the control sheep gained 11·75 lb.

The production of a hæmolytic anæmia in sheep after sustained dosing of nitrite, the recognized primary reduction product of nitrate, has been demonstrated. Three sheep were dosed twice daily with a total daily oral dose of 8 gm. of sodium nitrite/100 lb. live-weight over a period of 19–23 days. This dose was very close to the lethal limit and the animals were methæmoglobinæmic for a considerable portion of each day; nevertheless, they continued to graze in the normal way, made moderately satisfactory gains in weight and their rumen contents and rumen flora appeared to be normal. Three to five days after stopping the nitrite dosing, the serum showed the presence of hæmoglobin; one animal had very slight hæmoglobinuria on the seventh day, and by the eleventh day the packed red-cell volume of all three sheep had fallen from 38–40 per cent to about 25 per cent and continued to fall in two sheep until the twenty-first day to levels of 17 and 20 per cent, recovering slowly over the next eleven days. This effect could be attributed to a cumulative toxicity, but at the present stage of the investigation is considered to be due rather to the sudden withdrawal of substrate from the rumen adapted to handling nearly the maximal amount of nitrite. Under these conditions, there is a possibility of the release of a hæmolytic dose of hydroxylamine within 24–72 hr. of the cessation of nitrite additions to the rumen, conceivably arising from a reversal of the hydroxylamine → ammonia stage of the series of enzyme reactions.

Nitrate, which is a normal rumen metabolite for the grazing sheep, can vary markedly in its concentration in pasture, and there is now reason to believe that such variation in the diet of the animals can cause adverse effects. The present work strongly supports the view that hydroxylamine is an intermediate in the reduction of nitrate and nitrite to ammonia in the rumen. This compound or its oximes have hæmolytic activity if present in the blood-stream in sufficient concentration. The fact that toxic manifestations apparently identical with those due to hydroxylamine can be produced in the ruminant by interrupting an established nitrite metabolism gives a possible explanation of some of the metabolic disorders besetting sheep-grazing pasture of variable nitrate content.

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Goitrogen of Milk produced on Kale

In a recent report Clements and Wishart[1] have shown that when cows are grazed on kale they produce milk with goitrogenic properties. Their evidence for this consists of the discharge of accumulated radioiodine from the thyroid glands of schoolchildren on drinking the milk.

It is generally accepted (see review by Berson[2], among others) that goitrogenic substances fall into two classes: those which, like thiocyanate, block the iodide 'trap' of the thyroid and those, like thiouracil, which do not affect the absorption of iodide but prevent its binding into thyroglobulin. In addition, thiocyanate causes the discharge of the accumulated inorganic iodide from glands treated with the second type of goitrogen. I have not seen a report of an experiment designed to test the possibility that goitrogens of the thiouracil type behave similarly but, in view of the lack of interference of such substances with radioiodine accumulation, it is most unlikely that they do. In addition, I have treated sheep with thiouracil daily before and during radioiodine measurements and have seen no such effect, whereas

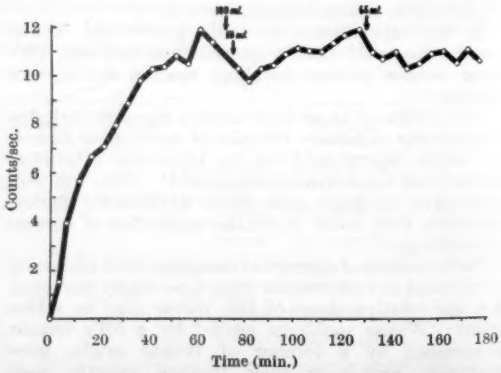

Fig. 1. The partial discharge of radioiodine by milk produced on kale in animals pre-treated with propyl-thiouracil

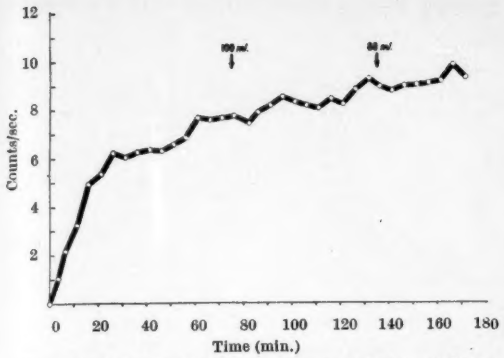

Fig. 2. The absence of discharge by milk produced on kale in animals without pre-treatment

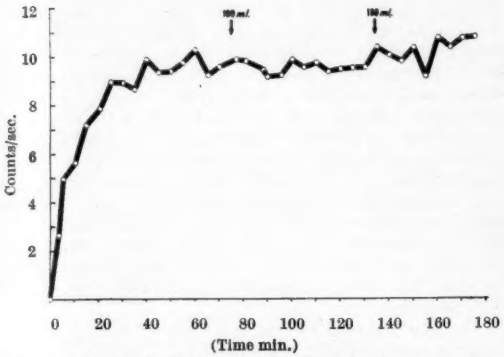

Fig. 3. The absence of discharge by milk produced on pasture in animals pre-treated with propyl–thiouracil

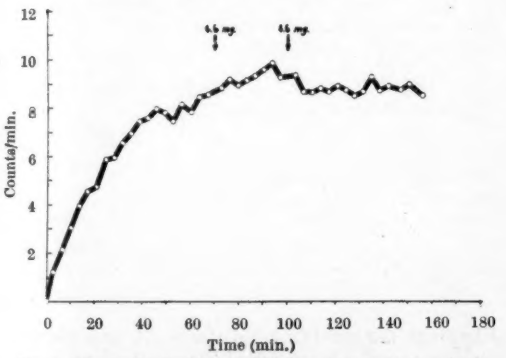

Fig. 4. The partial discharge by thiocyanate in water in animals pre-treated with propyl–thiouracil

thiocyanate produced a prompt discharge from a similarly treated group.

Brown Grant[3] gave 200 mgm. potassium thiocyanate to a rabbit which had been pre-treated with 50 mgm. thiouracil 4 hr. and 1 hr. before injection of radioiodine. His results lie on a curve which would be predicted on theoretical grounds. However, my results (unpublished) obtained from both sheep and rabbits usually show a partial discharge followed by a partial recovery. The degree of discharge appears to depend on the amount of thiocyanate given. Such curves resemble closely those obtained in Tasmania by Clements and Wishart[1]. This suggests that the schoolchildren used in their study were already suffering from inhibition of iodine binding and that the milk contained a goitrogen of the thiocyanate type. The presence of *iso*thiocyanates in brassicas[4] which might give rise to thiocyanate in the milk is also suggestive of this explanation. The results of some preliminary experiments which I have made support the hypothesis suggested above. This work is far from complete, but since it cannot be continued until the new season's kale is available, the results already obtained are briefly reported here.

A goat was fed on thousand-headed kale, and the milk produced was given by stomach tube to rabbits treated with propyl thiouracil and radioiodine in the manner of Brown Grant[3]. The results are shown in Figs. 1–4. The first graph shows the partial discharge caused by the kale-produced milk, while the result of giving the same milk to a rabbit without pretreatment is shown in Fig. 2. The graph of Fig. 3 was obtained with milk from pasture.

The milk produced from kale was analysed and found to contain 4·6 mgm. thiocyanate/100 ml., whereas milk produced from pasture contained only 0·8 mgm./100 ml. Results from an experiment in which the milk was replaced by 100 ml. of water containing 4·6 mgm. thiocyanate show that this can cause a discharge (Fig. 4). In this experiment the first dose failed to produce any discharge. Similar results have been recorded with samples of milk produced from marrow-stem kale. It is for this reason that at least two doses of the material being tested are given in each case.

These results strongly suggest that the goitrogenic activity of milk from ruminants fed on kale is at least partly due to the presence of a thiocyanate-type goitrogen. These experiments will be repeated and extended when the new season's crop is available. The results will be offered for publication in the *New Zealand Journal of Agricultural Research*.

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A Method of reducing the Losses caused by *Gloeosporium* spp. in Stored Apples

THE economic importance of losses in stored apples following the invasion of lenticels by *Gloeosporium album* and *G. perennans* has been stressed by Wilkinson[1]. More recently, it has been shown that losses can be reduced by the use of organic fungicides during the growing season (Montgomery, H. B. S., private communication and ref. 2), or by storing fruits obtained from young trees which have received low applications of nitrogen and are growing on heavy soil under a grass sward (Montgomery, H. B. S., private communication). Complete control might be obtained by eliminating the sources of spores on the trees in the orchard, or by preventing the infection of fruit from the spores normally present on their surface at harvest.

The latter method of approach has been studied at Wye College where, during investigations into the fungicidal properties of certain chemicals[2],

Table 1. Rotting of Cox's Orange Pippin in Store caused by *Gloeosporium* spp. Means of the Results of Three Methods of Assessment on Fruits kept at 39° F. for 17 Weeks

Control						Treated					
Tray No.	No. of fruits	Percentage of fruits with lesions*	Percentage of fruits without lesions*	No. of lesions per fruit†	Area of lesions per fruit‡	Tray No.	No. of fruits	Percentage of fruits with lesions*	Percentage of fruits without lesions*	No. of lesions per fruit†	Area of lesions per fruit‡
1	70	76·0	24·0	3·0	1·9	1	67	61·8	38·2	1·6	1·4
2	66	78·8	21·2	3·1	2·0	2	68	69·7	30·3	2·2	1·6
3	70	69·7	30·3	3·1	1·5	3	68	62·0	38·0	1·7	1·3
4	69	87·4	12·6	6·6	2·5	4§	68	71·8	28·2	2·2	1·6
5	66	75·8	24·2	3·0	1·7	5§	69	40·1	59·9	0·7	0·8
6	70	71·7	28·3	2·6	1·8	6§	69	39·0	61·0	0·6	0·8
7	71	62·5	37·5	1·4	1·1	7	69	40·4	59·6	0·6	0·8
8	71	75·2	24·8	3·7	1·7	8	71	70·3	29·7	2·0	1·6
9	72	79·6	20·4	4·1	2·2	9	69	64·8	35·2	1·7	1·3
Means	69·4	75·0	25·0	3·4	1·8	Means	68·5	57·7	42·3	1·5	1·3

* Mean of nine independent assessments.
† Mean of three independent assessments.
‡ Mean of three independent assessments (different assessors from †).
§ Impregnated liners fixed beneath these trays.

(2 : 4 : 5-trichlorophenoxythio)trichloromethane exhibited marked fumigant, antifungal properties. It was decided, therefore, to examine the effect of this compound on lenticel rotting of Cox's Orange Pippin during storage[4].

Experimental apples were obtained from 23-year-old trees on *M* IX rootstocks, and, to ensure a high incidence of infection, they were immersed in a suspension of spores of *G. perennans* containing approximately 20,000 spores per 1 ml. of 1 per cent dextrose solution. After dipping, some 70 fruits were placed in a single layer in each of 18 trays, two sets of nine trays being stacked vertically within polyethylene tents and placed in cold store at 39° F.

For the application of the compound, box liners were impregnated with the material and fixed to the underside of the trays, since it had been found previously that if fruits were stored in direct contact with the impregnated paper a certain amount of browning of the skin developed.

As information on the physical properties of (2 : 4 : 5-trichlorophenoxythio)trichloromethane is lacking, treated liners were fixed beneath the middle three trays only so that information could be obtained on the effect of upward and downward movement of the vapour. The material, in solution in acetone, was sprayed on to the three box liners so that the total amount of chemical was equal to 1 gm./10 ft.^{3} of air space inside the tent, 5 ft. × 2 ft. × 2 ft.

The experiment was started on October 7, 1957, and the amount of rotting was assessed on February 4, 1958, by each of the following indices: (1) the number of fruits with *Gloeosporium* lesions; (2) the number of *Gloeosporium* lesions on infected fruits; (3) the area of *Gloeosporium* lesions on infected fruits. The estimated total area of all lesions on each apple was based on an arbitrary scale (0–4) where 0 is no lesion and 4 is total lesion area greater than 1 in.^{2}. A summary of the results is given in Table 1.

These show that *Gloeosporium* rotting of apples in cold storage was reduced by the use of (2 : 4 : 5-trichlorophenoxythio)trichloromethane as a fumigant. Of the untreated fruits only 25 per cent were free of lesions, whereas throughout the nine treated trays 42·3 per cent had no *Gloeosporium* lesions and, in particular, of the fruits in the three trays which had impregnated box liners immediately above them, 60·2 per cent were free of lesions. There was an average of 3·4 lesions per fruit in controls, 1·5 lesions per fruit in the treated trays and in the three trays with chemical above, only 0·63 lesions per fruit (that is, only 18·5 per cent of the number in controls).

Although infection was by no means completely prevented, it should be noted that the overall infection of the fruits was excessive because of the heavy artificial inoculation prior to storage. When it is remembered that for storage of apples to be economical the grower can afford to lose no more than about 10 per cent of the apples, a reduction in the percentage of rotted fruits as achieved here would make the difference between loss and profit in many apple stores. Other methods of application of the chemical are to be investigated, but the use of treated box liners would seem to be a practical method for the commercial application of chemicals, and it is intended to examine this method more closely with apples that have not been artificially inoculated before storage.

We are grateful to our colleagues for help in this experiment and in particular to Dr. C. H. Fawcett, who provided the chemical and to Miss S. Uings for personal assistance.

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Atypical Guard-Hair Follicles in the Skin of the Rabbit

Hair follicles in the rabbit grow in clusters that are usually composed of one large guard-hair follicle and many small down-hair follicles[1]. In rabbit skin Whiteley[2] has described the occasional occurrence of clusters that contain several guard hairs. These large clusters are 0·5–1 cm. apart and are accompanied by visible elevations on the surface of the skin.

In the present study small thickened areas of epidermis, that are also visible on the surface of the skin, have been found associated with atypical guard-hair follicles in the skin of Dutch rabbits. These atypical follicles are unlike normal guard-hair follicles because they are part of an organelle that may have a tactile function. They are scattered over

Fig. 1 Fig. 2 Fig. 3

Fig. 1. The epidermal pad is at the left of this atypica lguard-hair follicle. The capillaries are in cross section at both sides of the follicle. (× 100)

Fig. 2. The arrow indicates the position of the nerve fibres that enter the ring-like arrangement of connective tissue from the left side of this follicle. (× 130)

Fig. 3. The bi-laminar structure is composed of uniformly arranged fibres that are stained with gold chloride. (× 310)

the dorsal skin and have a distribution similar to the "giant compound hair follicles" described by Whiteley. Single atypical follicles occur at intervals of approximately 1 cm. in adult rabbits. In young animals they are more closely arranged. Fig. 1 shows a histological section of one of these resting, atypical guard-hair follicles, which was stained with van Gieson's picric acid – fuchsin stain and with alum hæmatoxylin. Below the epidermis in each atypical follicle there is a ring-like arrangement of coarse connective tissue fibres, which encloses a network of capillaries. This complex surrounds the narrow neck of the hair follicle. When skin containing resting follicles is rubbed, the capillary network dilates and becomes visible to the eye as a small red mark, which soon disappears. This reaction is not obvious in skin containing growing follicles. Posterior to the opening of each atypical follicle there is a thick pad of epidermal cells, and this forms the visible elevation on the skin. A row of many down-hair follicles is arranged along the border of this epidermal pad. All these structures are enclosed in a common mass of connective tissue that has fibres of finer texture than those in the adjacent dermis or in the ring of connective tissue around the atypical follicle.

A longitudinal histological section of a resting, atypical guard-hair follicle, stained with gold chloride for the demonstration of nerve endings, is shown in Fig. 2. The ring-like arrangement of connective tissue, containing the capillary network, stains darkly with gold chloride. It is consistently innervated from the posterior side. Some of the nerve fibres enter a bi-laminar structure, which is present only at the lower inside border of the connective tissue ring. This structure is composed of inner fibres that encircle the hair follicle and of outer fibres that run vertical to the follicle. These lamellæ have the appearance of a grid when they are viewed tangentially (Fig. 3). Other nerve fibres terminate in a complex of nerve endings below the epidermal pad.

This abundant innervation and the presence of the capillary component suggest that these atypical follicles are highly specialized tactile organelles. A more detailed account of their morphology, in both the resting and growing phases, will be published elsewhere. This study was supported by the National Cancer Institute of the United States Public Health Service.

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Aberrant Recombination at the *am* Locus in *Neurospora crassa*

A number of independently induced mutant alleles are known at the 'amination-deficient' locus in *N. crassa*. Previous work with four different *am* mutants, designated am^{29}, am^{33}, am^{47} and am^{R} has shown that certain combinations of these *am* alleles in pairs in heterocaryons were complementary[1,2]. In addition, apparently true wild-type ascospores were found in low frequency in the progeny of most crosses between strains which carried non-complementary *am* alleles.

The frequencies of wild-type production by various crosses between non-complementary *am* alleles were not easily explained in terms of recombination due to crossing-over of the classical type. Consequently, it was decided to repeat the cross between the pair of *am* alleles which gave the highest frequency of wild-types ($am^{29} \times am^{47}$), with marker genes on each side of the *am* locus. The markers used were the inositoless strain 37401, and a morphological mutant known as 'spray'. The mutant spray was kindly supplied by Dr. R. W. Barrett (Dartmouth College, United States), who also located the *am* locus in chromosome V. The inositol locus is about 2–3 cM. distal to *am*, while spray is about 5–8 cM. distant from *am* proximal to the centromere. Two types of cross were set up, *sp* $am^{47} \times am^{29}$ *inos* and *sp* $am^{29} \times am^{47}$ *inos*, and the ascospores plated on a selective medium. Any wild-type colonies which appeared were transferred

Table 1. Wild-type 'Recombinants' from *am* × *am* Crosses

Cross	Genotypes				No. of wild-types	No. of live asco-spores in thous-ands
	sp + +	+ + +	*sp* + *inos*	+ + *inos*		
$am^{29} \times am^{29}$	—	—	—	—	0	585
$am^{47} \times am^{47}$	—	—	—	—	0	465
$am^{29} \times am^{47}$	—	—	—	—	14	651
sp am^{47} × am^{47} *inos*	—	—	—	—	0	209
sp am^{29} × am^{47} *inos*	9	0	8	7	24	1,214
sp am^{47} × am^{29} *inos*	17	0	6	0	23	1,549

and classified for the markers *sp* and *inos*. The results are given in Table 1, the first three lines of which are from a previous publication[2] and serve for comparison with the marked crosses.

It is clear that the frequencies of the various kinds of wild-type obtained from the marked $am^{29} \times am^{47}$ crosses do not correspond to those expected on the hypothesis that the wild-types are produced by classical crossing over. There is a great excess of strains which are parental in type with respect to the markers *sp* and *inos* and consequently would have to be regarded as double cross-overs on the classical model. Furthermore, in the two complementary types of cross, the frequencies of the two cross-over types and of the two parental types should be reversed. That this is not so can be seen from line 6 of Table 1. Whatever the assumed order of the *am* alleles, one of the types of cross should give the genotype + + + as the most frequent type of recombinant. This genotype would be the result of a cross-over between the two *am* alleles with no other accompanying cross-over between the markers *sp* and *inos*. But there were no strains with the genotype + + + out of a total of forty-seven wild-types.

If the recombinants at the *am* locus were due to crossing over or to gene conversion[3,4], then both the markers *sp* and *inos* might be expected to show a 1 : 1 segregation. There is, in fact, a significant excess of *sp* from both types of cross, although this is far more extreme in the *sp* $am^{47} \times am^{29}$ *inos*, with the result that the heterogeneity χ^2 is significant at the 0·005 per cent level. This excess of spray might be a viability effect, with the wild-type allele at the spray locus at a relative disadvantage under the experimental conditions. If this were so, then the frequency of wild-types from the marked crosses (about 1 in 59,000) should be twice the frequency in unmarked crosses (about 1 in 45,500). The difference between the two frequencies does not appear to be as large as this. There is also the consideration that the segregation ratios of spray to non-spray in the complementary types of cross are significantly different, which does not suggest a viability effect. Finally, it seems unlikely that a mutant allele such as spray could have such a strong selective advantage over the wild-type allele, and other work with this mutant has never suggested any selective advantage of spray under similar experimental conditions.

Only the *sp* $am^{47} \times am^{29}$ *inos* cross shows a significant deviation from a 1 : 1 segregation with respect to the *inos* marker, and the combined totals for this marker fit the hypothesis of a 1 : 1 segregation. But the deviations from 1 : 1 in each type of cross are in opposite directions, with a resultant heterogeneity χ^2 which is significant at the 0·025 level. These results suggest that the complementary crosses are significantly different with respect to the distribution of the spray and inositol markers in the recombinants at the *am* locus.

It is difficult at present to suggest any mechanism of recombination which could account for the observed results. There is a tendency for that allele at the inositol locus which is put into a cross in conjunction with the am^{47} allele to be present in excess in the recombinants at the *am* locus. Although there is an excess of spray from both types of cross, the seven recombinant strains which were non-spray all came from the cross in which the + allele at the spray locus was combined with the am^{47} allele in one of the parental strains. It may be that a segment of chromosomal material carrying the am^{47} allele is preferentially included during the formation of a wild-type recombinant at the *am* locus. But even if this were the case it is still necessary to suppose that the spray locus has some effect on the mechanism of recombinant formation at the *am* locus.

It is hoped that extensive test crossing of these aberrant recombinant wild-types and the study of further $am^{29} \times am^{47}$ crosses with other linked markers may elucidate the situation. Meanwhile, it seems desirable to publish these results, for they do not seem explicable in terms either of crossing-over or of gene conversion.

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Use of the Membrane Filter in Mycological Class-work

The molecular filter membrane, which is especially useful in sanitary bacteriology and related fields, has recently been shown to be very valuable in the cultivation and identification of fungi[1]. The method has also been applied with great success in microbiological class-work for university students. Instead of a number of plates, a single membrane filter culture is sufficient for a large number of students. The mechanical breakage of the mycelial structures is avoided, and in addition, it simplifies the lecturer's preparatory work.

Use is made of membrane filters available commercially and delivered in sterile packets, in which each filter is separated from the other by an absorbent pad. A pad is placed at the bottom of a sterile Petri dish and approximately 2 ml. sterile yeast water, double strength, is added, so that the pad is evenly moistened. A sterile membrane filter is put on top, taking care to avoid air bubbles between the filter disk and the pad. The moistened filter disk is inoculated from a fungus culture by streaking with a zig-zag motion over its surface, and the dish is incubated at room temperature for two to three days. When growth occurs, the membrane filter is cut into pieces with sterile scissors and dried at 50° C. for 20–30 min., or preferably at room temperature for 3–4 hr. A few drops of standard immersion oil (n = approximately 1·50) are put on a slide and a piece of the dried membrane filter carrying the culture placed on top. After a few seconds the membrane is rendered almost completely transparent as soon

as the pores are filled with the immersion oil, since the membrane has the same refractive index as the immersion oil. The specimen is now ready for inspection by microscope, using transmitted light.

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Oslo.

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Pogonophora from the Atlantic

IT is becoming clear that the distribution of the Pogonophora is less limited than was formerly supposed. In the past few years the area of known occurrence has been extended beyond the Pacific Ocean to the Arctic basin[1], the Greenland Sea[1] and the Skagerak[2,3]. We have now found some of these interesting animals on the continental slope to the south-west of the British Isles; they are the first to be recorded from the Atlantic Ocean proper.

Our specimens of Pogonophora were obtained on May 4, 1957, by R.V. *Sarsia*, at a single station just west of the Little Sole submarine promontory: position, lat. 48° 28′ N., long. 10° 04′ W.; depth, 700 fathoms by echo-sounding, with a relatively level profile; bottom deposit, mud containing a little fine sand and foraminiferan shells. A 20-min. haul of the dredge produced the following Pogonophora:

	Tube length (cm.)	Tube width (mm.)	Length of animal less tentacle (cm.)	Width of animal (mm.)	No. of specimens
Siboglinum sp. *A*	up to 40	0·5	up to 13	0·4	15
sp. *B*	up to 10	0·12	up to 3	0·09	7
sp. *C*	up to 5	0·14–7	up to 2·5	0·12–5	3

These species will be described in more detail elsewhere; *B* and *C* resemble the Skagerak species *Siboglinum ekmani* Jägersten.

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Resistance to Flow in Vascular Beds

THE concept of resistance to flow is widely used by physiologists and clinicians when inferring vessel behaviour from pressure and flow data. For a great number of years 'resistance to flow' has been defined by physiologists as the ratio of the pressure drop across a vessel system to the flow that results. As so defined, Burton[1] has pointed out that ". . . resistance to flow is strictly analogous to 'resistance' in electrical measurements, which is defined by Ohm's Law", and he believes that "resistance to flow remains a useful clarifying concept". The resistance unit most widely used is the peripheral resistance unit (p.r.u.), which is, according to Green[2], "equivalent to the ohm", and is defined as 1 p.r.u. = 1 mm. mercury/1 ml. per min.

However, the Ohm's law analogy provides reliable information regarding vessel behaviour (in the absence of turbulent flow and changes in viscosity of the perfusion fluid) only when the pressure-flow curve passes through the origin; in such conditions the resistance to flow may be expressed (in peripheral resistance units) as the reciprocal of the slope of the pressure-flow diagram at any given point.

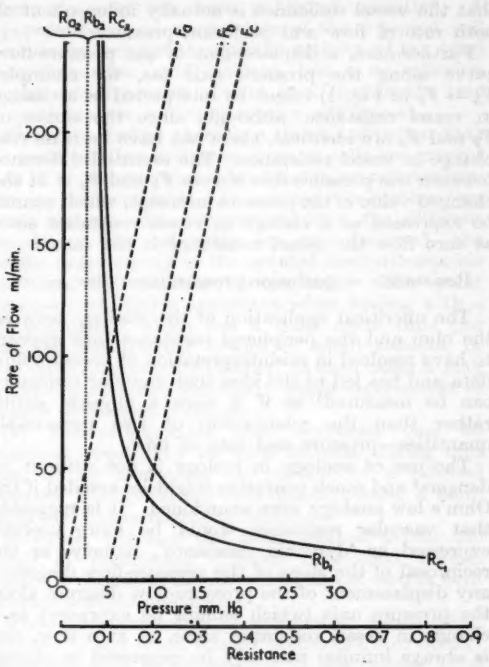

Fig. 1. Relations between: rate of flow and perfusion pressure (broken line); rate of flow and resistance to flow in peripheral resistance units (continuous line); rate of flow and resistance to flow in dynamic resistance units (dotted line), in three different vessel systems

Unfortunately, the pressure-flow curves of vascular beds rarely, if ever, pass through the origin, but usually exhibit a positive pressure intercept so that uncritical use of the Ohm's law analogy may be misleading.

Fig. 1 shows three pressure-flow diagrams: F_a is the pressure-flow characteristic of a system in which the vessel walls are rigid; here resistance to flow may legitimately be expressed in peripheral resistance units as the reciprocal of the slope. F_b and F_c represent the pressure-flow relations in two vessel systems across which a positive pressure gradient must be established before flow commences; both F_b and F_c intercept the pressure axis at positive values. But since the slopes of F_a, F_b and F_c are identical, vessel resistance is the same in all three systems, and (since the pressure-flow curves are rectilinear) is independent of both pressure and rate of flow.

Fig. 1 also shows the relations between rate of flow and vessel resistance in the vascular systems *b* and *c*, expressed (1) in peripheral resistance units by the Ohm's law analogy (continuous line) and (2) as the reciprocal of the slope of the pressure-flow diagram (dotted line). Resistance to flow expressed in peripheral resistance units as defined by Burton[1] appears to be dependent upon rate of flow, although it is clear from the rectilinear pressure-flow diagrams

that the vessel resistance is actually independent of both rate of flow and perfusion pressure.

Furthermore, a displacement of the pressure-flow curve along the pressure axis (as, for example, $F_b \rightarrow F_c$ in Fig. 1) might be interpreted as a change in vessel resistance, although, since the slopes of F_b and F_c are identical, there can have been no real change in vessel resistance. The essential difference between the pressure-flow curves F_b and F_c is in the changed value of the pressure intercept, which cannot be expressed as a change in vessel resistance since at zero flow the vessel resistance is the same:

$$\text{Resistance} = \text{perfusion pressure/zero flow} = \infty$$

The uncritical application of the analogy between the ohm and the peripheral resistance unit appears to have resulted in misinterpretation of pressure-flow data and has led to the idea that vascular resistance can be measured[2] as if it were a physical entity rather than the relationship of two measurable quantities—pressure and rate of flow.

The use of analogy in biology is not without its dangers[4] and much confusion might be avoided if the Ohm's law analogy were abandoned. It is suggested that vascular resistance would be more usefully expressed as 'dynamic resistance', namely, as the reciprocal of the slope of the pressure-flow diagram; any displacement of the pressure-flow diagram along the pressure axis (which cannot be expressed as a change in vessel resistance since, at zero flow, this is always infinite) can only be expressed as change in pressure intercept. Thus 'resistance to flow' might more profitably be expressed in two parts as (1) pressure intercept and (2) dynamic resistance (reciprocal of the slope of the pressure-flow characteristic).

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Chemical Analysis of Holothurian Sclerites

The Holothuroidea differ from all other echinoderm classes in having a greatly reduced skeletal system. Typically, external plates are absent, while a peripharyngeal crown, anal plates, madreporite and spicules are usually present. Of these, the endoskeletal spicules (or ossicles), formed in superficial dermal layers, constitute the outstanding character of the class, and are of paramount importance in the specific identification of Recent forms. Although it has been continually stated that such holothurian spicules, as with all other echinoderm skeletal elements, consist entirely of calcium carbonate, few accurate attempts to analyse them chemically have been made[1]. It seems of interest, therefore, to record results obtained by a chemical examination of spicules from a typical aspidochirote holothuroid, *Holothuria impatiens* (Forskäl), a littoral species of circumtropical to subtropical distribution.

The Indo–West Pacific specimen studied was wet-ashed overnight in a mixture of hydrogen peroxide and sodium hydroxide. The resulting residue was washed thoroughly with distilled water and dried, the endoskeletal spicules then being separated from the larger skeletal elements and extraneous matter (gut contents, etc.) by sieving. Approximately 20,600,000 spicules were recovered, representing about 10 per cent (2·2 gm.) of the alcohol-preserved body-weight. Solubility in normal hydrochloric acid, with evolution of gas, indicated the presence of alkaline-earth carbonate; pink-violet fluorescence apparent under short-wave ultra-violet light (2537 A.) at room temperature suggested a considerable percentage of calcium carbonate[2].

Table 1. Radicals determined in Holothurian Endoskeletal Spicules

Radical	Percentage	m.equiv.*
Ca	35·18	1·756
Mg	3·36	0·276
CO_3	60·80	2·026
PO_4	0·29	0·009
Cu; Fe; Pb; Sr; Zn	Traces†	Total cations
Ba; Bi; SO_4	nil	2·032
Protein	nil	Total anions
Acid-insoluble residue	0·01‡	2·035
Total	99·64 per cent.	

* Based on 100 mgm. sample.
† Percentage for each radical < 0·001.
‡ Extraneous Si, etc.: sand grains, Porifera spicules and Radiolaria.

Calcium was determined by oxalate titration and confirmed by flame photometry; magnesium spectrophotometrically by the titan yellow method[3] and oxinate titration; carbonate by weight loss following the addition of acid in a Shrötter alkalimeter[4]; and phosphate by the molybdenum blue spectrophotometric method[5]. The minor constituents were determined by standard spot-tests.

The aspidochirote spicules investigated represent isomorphous complexes of calcium, magnesium and carbonate, with traces of accessory elements (Table 1). Employing petrological techniques, Schmidt[6] found the spicules of several holothurian genera and species to be single crystals of calcite, and it is interesting to note that spicules from many molpadiid holothuroids are frequently coated with, or replaced by, iron phosphate[1,7]. In the present material, however, the iron radical constituted a negligible trace.

It has been noted that in warm waters part of the calcium content of marine shells may be substituted by magnesium[8]; Clarke and Kamm[9] have further demonstrated that, in the Asteroidea, several species show a progressive enrichment of magnesium following a temperature increase, the proportion of magnesium carbonate ranging from 11 to more than 14 per cent in tropical waters. In view of the magnesium content of the spicules analysed, and noting the tropical origin of the specimen from which they were derived, it seems possible that a similar phenomenon may occur in the Holothuroidea. If so, positional variations in the optical axis of holothurian spicules (considered to be of taxonomic significance by Schmidt[6,10]) may partly result from varying concentrations of magnesium, and be of ecological rather than taxonomic importance.

I am greatly indebted to Mr. P. L. Bradley for his invaluable technical supervision during this study; and to Miss A. M. Clark, of the Department of Zoology, British Museum (Natural History), for

allowing me to examine duplicate holothurian material in her charge.

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Pitfalls of Specific Radioactivity in measuring Synthesis of Deoxyribonucleic Acid

SINCE the introduction of radioactive labels in biological research a tendency has arisen to measure the specific radioactivity of nucleic acid components (usually expressed as counts per minute per μmole or mgm. material) and to equate such measurements with a synthesis of deoxyribonucleic acid, or even growth-rate of tissues. Certain factors are, however, frequently neglected.

(1) If to a population of living cells a certain deoxyribonucleic acid label is added, then the specific radioactivity of the acid after a certain time will depend on: (*a*) the proportion or fraction of the whole population of cells synthesizing, (*b*) the amount of deoxyribonucleic acid synthesized per cell during unit time, which means that: (a) 100 per cent of the cells synthesizing at half normal rate, (b) 50 per cent of the cells synthesizing at normal rate, (c) 25 per cent of the cells synthesizing at twice normal rate will yield an identical specific radioactivity of the isolated deoxyribonucleic acid.

(2) Since the concept of the cell-cycle in relation to synthesis of deoxyribonucleic acid has been established[1,2] it is clear that it is synthesized only for a limited period during the interphase. In different tissues and different species varying lengths of pre- and post-synthetic periods precede or follow the actual process of synthesis (*S* period). Consequently the timing of incubation with a labelled precursor is not a negligible factor in evaluating results of specific activity determinations.

In human bone-marrow cells, for example, during a short-term incubation (3–4 hr.) only those cells will become labelled which at 0 hr. were already in their *S* period. Cells in their pre- or post-synthetic periods will not collect the label. In a long-term (24 hr.) incubation, however, there is time for considerable proportion of the cells to progress from their presynthetic period to their *S* period, or even from their post-synthetic period through mitosis and presynthetic period to *S* period. Clearly any factor influencing the rate of progress through the pre- or post-synthetic period (or mitosis) will affect the number of cells arriving at the *S* period. Evidence that such effects do exist has been published recently[3]. A depopulation or overpopulation of the *S* period will decrease or increase the specific activity of the total deoxyribonucleic acid isolated, but is no reflexion on the actual process of synthesis, that is, the rate of synthesis per cell may remain unchanged.

Therefore, unless there is a direct indication that the same number and same type of cells are present at 6–12 hr. as were at 0–6 hr. (that is, no cell destruction, no differentiation into mature non-synthesizing forms occurs), and furthermore that the different periods of the cell-cycle are not distorted, the specific radioactivity of the isolated deoxyribonucleic acid does not measure its synthesis. This point becomes particularly important when dealing with a cell population which has a short cycle time (for example, fast-growing tissues of small rodents, or even more so, micro-organisms); in such cases it may be difficult to design sufficiently rapid experiments to exclude population changes.

(3) Deoxyribonucleic acid synthesis can be measured directly by its total increase during unit time, or by measuring the uptake of a labelled precursor into individual cells directly, using a high-resolution autoradiography method.

However, although the latter method avoids the pitfall of population changes mentioned before, caution is needed in the interpretation of results with different labelled precursors.

While incorporation of phosphorus-32, formate-^{14}C, adenine-^{14}C and other similar precursors into deoxyribonucleic acid, if investigated at the cellular level (that is, grain counting on autoradiographs over individual cells), may well reflect on the rate of synthesis, changes in the rate of incorporation are not necessarily connected with changes in the rate of synthesis. Cells will synthesize deoxyribonucleic acid even without the addition of labelled precursors. Stimulation of formate-^{14}C incorporation into deoxyribonucleic acid (for example, with citrovorum factor) is more likely to be a result of 'pushing' the formate carbon into the 5 methyl position of thymine, than of stimulation of deoxyribonucleic acid synthesis. Similarly, depression of phosphorus-32 incorporation (for example, with radiation) may reflect equally on a dilution of the phosphorus pool (phosphates released from damaged mitochondria) and on true depression of synthesis.

The incorporation of labelled thymidine (^{14}C or ^{3}H) is more likely to reflect on the assembly of the deoxyribonucleic acid molecule than the incorporation of earlier precursors depending on the efficiency of series of reactions. Even so, unless proved, thymidine incorporation and deoxyribonucleic acid synthesis are not quantitatively interchangeable terms. Irrespective of whether radioactive labelling methods or direct measurements of deoxyribonucleic acid increments are used, the investigation has to be carried out at the cellular level; otherwise population effects and cell-cycle changes make interpretation of the results impossible.

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Radio Noise from Meteors

An average meteor releases energy at a rate of 100 megawatts as it is disintegrated in the Earth's upper atmosphere. A portion of this energy is converted into heat and light, and it is possible that energy is also emitted in other parts of the electromagnetic spectrum, at high and low radio frequencies. Plasma resonance of the ionized trail and deceleration of electrons and ions, for example, are possible mechanisms for radio emission. Preliminary experiments conducted by Kalashnikov[1] in the U.S.S.R. seemed to show that meteors produced radio noise at the lower end of the spectrum, at a frequency of about 1 c./s. His equipment consisted of a search coil, 100 m. in diameter, that was connected to a sensitive moving-coil galvanometer. With this magnetometer a field change of 4×10^{-8} oersted, or $4 \times 10^{-2}\gamma$, could be detected, and pulses were obtained simultaneously with the occurrence of a meteor. I have recently repeated the magnetometer experiment, and measurements have also been made at other points in the electromagnetic spectrum, so that meteor noise has been investigated at the frequencies: 1 c./s., 30 Mc./s., 218 Mc./s. and 475 Mc./s.

Harvard College Observatory has operated, since 1954, two Super-Schmidt camera stations at Sacramento Peak and at Mayhill, New Mexico. These cameras obtain parallactic photographs of meteors from which their height and velocity can be deduced. The magnetometer was situated at Sacramento Peak because this site was comparatively free from magnetic interference. A search coil of 10 turns and 100 m. in diameter was laid 6 in. below the surface of the ground and was connected to a low-frequency amplifier[2]. On magnetically quiet days it was possible to detect a test pulse of $3 \times 10^{-2}\gamma$, a sensitivity similar to that of the Russian equipment. The signal from the magnetometer was displayed on a pen recorder. An observer at the camera site marked the record by operating a push-button to show the instant of occurrence of a meteor. The 30-Mc./s. and 475-Mc./s. radiometers were situated at the Mayhill site and a similar recording procedure was followed. The 218-Mc./s. equipment placed at the Agassiz Station of Harvard College Observatory, at Harvard, Massachusetts, consisted of a Dicke-type radiometer in which the antenna signal was compared with the noise in a constant-temperature resistor. Photographs were not taken at Agassiz, but the occurrence of meteors was noted visually. The sensitivity, type of antenna and other details of each equipment are given in Table 1. The flux of 1 Jansky unit, used to define sensitivity, is equal to 1 watt $m.^{2}$ $sec.^{-1}$. In addition, Table 1 gives the minimum power output per unit band-width that could be detected from a meteor at a range of 150 km.

Table 1. Characteristics of the Equipment

Frequency	475 Mc./s.	218 Mc./s.	30 Mc./s.	1 c./s.
Band-width	2 Mc./s.	1 Mc./s.	2 Mc./s.	8 c./s.
Integration time	1 sec.	1 sec.	1 sec.	1 sec.
Noise factor	10 db.	4 db	9 db.	—
Sensitivity (Janskys)	1×10^{-22}	1×10^{-22}	2×10^{-19}	2×10^{-19}
Minimum power (watts/c./s.)	3×10^{-11}	3×10^{-12}	6×10^{-9}	62
Antenna	17-ft. paraboloid	24-ft. paraboloid	half-wave dipole	100-m. coil × 10
Beam-width between 3 db. points	8°	12°	40°	—
Beam-width between first minima	16°	24°	90°	—
Observation period	Dec. 1956–Aug. 1957	Feb. 1957–April 1957	Dec. 1956–Aug. 1957	Mar. 1957–Aug. 1957
No. of meteors	36	27	55	130

The results of the search for meteor radio noise will be given in detail elsewhere[3,4]. No emission from meteors was detected with any of the receiving equipments. It can be seen from Table 1 that a total of 248 meteors passed within the sensitive range of the equipment. These meteors had visual magnitudes between −1 and +5, with a median value of +2·5. Thus it is probably true to state that meteors do not emit radio noise within the frequency-range 1 c./s.–500 Mc./s. above the limits of sensitivity of these measurements. Meteors therefore show a surprisingly low efficiency in converting kinetic to radio energy. Their radio efficiency is certainly less than 10^{-11} per unit band-width. The disagreement between this work and the results of Kalashnikov is attributed to a misinterpretation of results by the latter; a more detailed discussion will be given elsewhere[3].

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Radio Scintillations of Satellite 1958α

There has been much speculation in recent years concerning the height of the irregularities in the Earth's ionosphere which are responsible for the scintillations in the signals received from discrete sources of cosmic radio emission. Hewish[1] concluded that the irregularities are at a height of about 400 km., whereas Booker[2] has recently suggested that they are substantially lower—between the *E* and *F* regions; other authors have found correlation between scintillation activity and the occurrence of spread-*F* and sporadic-*E* conditions.

Observations of the 108-Mc./s. radio signal transmitted by the artificial Earth satellite 1958α began in Sydney soon after its launching on February 1, and continued until March 10. The object was, first, to discover whether the satellite's radio signal exhibited scintillations and, secondly, if such scintillations existed, to use them for obtaining a more direct estimate of the height of the electron irregularities.

Scintillations were in fact often observed, and some of the records obtained are reproduced in Fig. 1. Here *a* refers to the 108-Mc./s. signal recorded on a night when scintillation was negligible and *b* to the signal when propagated through a highly disturbed ionosphere. The recordings *c* and *d* showed marked scintillations when the satellite was observed near perigee, for which the vertical height was 350 km. These observations were made with a half-wave dipole located λ/4 above a horizontal plane reflector and connected to a sensitive receiver of band-width 100 kc./s. The output recorder had a very fast response time (less than 0·02 sec. full-scale deflexion) and ran at a chart-speed of 2·5 cm./sec.

The recordings are seen to contain two types of modulation—fast, irregular fluctuations which are identified as scintillations, and an apparently regular modulation with a period of approximately 7 sec.

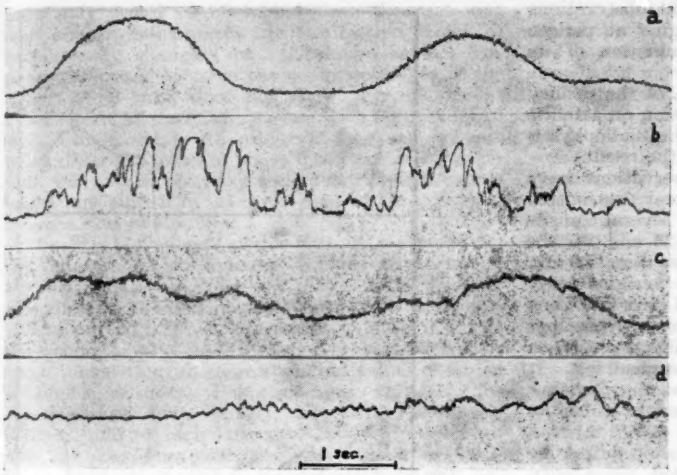

Fig. 1. Recordings obtained for satellite 1958α; (*a*) 2143 E.A.S.T., March 6, 1958; (*b*) 0403 E.A.S.T., Feb. 11, 1958; (*c*) 0046 E.A.S.T., Feb. 25, 1958; (*d*) 2151 E.A.S.T., Feb. 23, 1958

Simultaneous measurements taken with mutually perpendicular aerials showed that this slow modulation was due to a regular rotation of the plane of polarization of the radiation, and it was therefore concluded that the effect was caused by bodily rotation of the satellite.

Three pieces of evidence suggest that the fast fluctuations are scintillations of the type shown by cosmic radio sources: (1) the fluctuations are usually random in appearance; (2) the average duration of the peaks (less than 1 sec.) is consistent with that predicted for a source with angular velocity about 100 times that of a cosmic radio source; (3) there is a correlation between the times of appearance of such modulation and the occurrences of scintillations of the cosmic radio sources. This correlation is shown in Table 1, from which it is apparent that there is a tendency for the satellite fluctuation index to be high on days when the source fluctuation index is high. On ten of the eleven days when the cosmic sources showed intense scintillations, a high index was also obtained for satellite 1958α. The one exception occurred on February 27—one day after perigee.

Table 1. CORRELATION BETWEEN THE FLUCTUATION INDEX FOR THE COSMIC RADIO SOURCES HYDRA-*A*, VIRGO-*A* AND TAURUS-*A* AND THAT FOR THE SATELLITE 1958α

Cosmic source index	Satellite index	
	High	Low
High	10 days	1 day
Low	8 days	9 days

The fluctuation index used here is defined as the average, over a suitable time-interval, of the ratio of the root-mean-square deviations from the mean to the mean level. The index is taken as high when it is equal to or greater than 0·3. Table 1 contains results for 28 days on which several transits of the satellite and two or more of the strong cosmic radio sources were observed in the same period. The observations of cosmic radio sources were made with the Mills cross aerial at the nearby frequency of 85·5 Mc./s. The sources Hydra-*A*, Virgo-*A* and Taurus-*A* were used, more weight being given to Hydra-*A* as this was observed for more than an hour in its passage through the fan beam of the north–south arm of the aerial. The zenith angles of the sources at transit ranged from 22° to 56° and corresponded approximately with the range of zenith angles of satellite 1958α on its recorded transits.

The scintillation activity shown by the satellite on 31 nights (82 transits) is summarized in Fig. 2. Here the vertical lines show the range of scintillation indices observed on each night, the index being assessed for each minute interval of the satellite's passage. For comparison, the nights of high cosmic source scintillation (index $\geqslant$ 0·3) are indicated on the graph by the numbers, which give the average cosmic source indices for these nights. As might be expected from the irregular nature of the scintillations, there is not a one-to-one correspondence between the indices for the satellite and the cosmic sources. However, the general relation indicated by the correlation table can be seen—most of the high values of index for satellite 1958α occurred on days of high index for the cosmic sources.

Fig. 2 shows that there was no significant decrease in the scintillation of the satellite near perigee, when the height decreased to 350 km. Furthermore, if Fig. 2 suggests that any decrease in the correlation with the cosmic source index occurred near perigee, it is not particularly in the sense of less-intense satellite scintillations. It may therefore be concluded that the region of the ionosphere producing the scintillations must lie below 350 km., and may in fact be well below this height. Because of the wide scatter in the values of scintillation index observed on any one night (Fig. 2) and because of uncertainties as to the form of the scattering or focusing region, it does not seem possible to use the present observations to define a definite height for

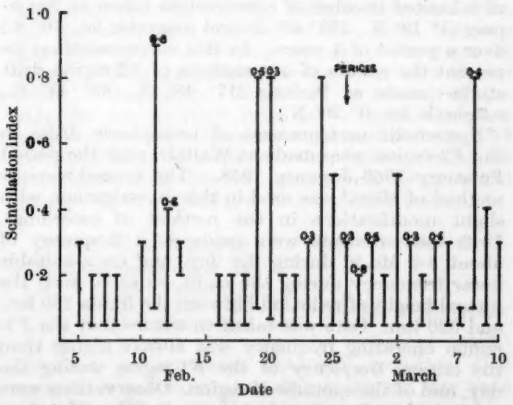

Fig. 2. Chart showing the range of the satellite's scintillation index for each night's recording. The numbers in the diagram give the values of the average scintillation index for cosmic radio sources for nights when its value > 0·3. The date of perigee is marked by the arrow

the layer. However, it is hoped that observations of other satellites having lower heights at perigee will permit a more accurate determination of its location.

I am indebted to Mr. G. Pateton, of the Sydney Moonwatch Group, for orbit information on satellite 1958α, and to Dr. J. A. Roberts, of the Radiophysics Laboratory, for useful discussion of the results.

Note added in proof. Some observations have recently been made of the radio signal transmitted on 108 Mc./s. by satellite 1958γ. On several transits during the daylight hours of April 23 and 24, the vertical height of this satellite was less than 200 km. The scintillation activity appeared to be significantly less on these days than on the several days preceding and following perigee; however, most recordings taken at perigee showed some scintillations and, on one transit, the scintillation index reached 0·2. It appears from these observations that the day-time scintillations are produced by electron irregularities situated below the height of perigee (185 km.) at a distance for which their focusing and/or diffracting power is becoming noticeably reduced.

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Horizontal Ionospheric Drifts in the *F*2-Region at Equatorial Latitudes

Ionospheric *F*2-region drifts have been studied in great detail at a number of high-latitude stations, and the results of these investigations have recently been summarized by Briggs and Spencer[1]. Considerable importance is attached to the drift studies at low-latitude stations in view of the recent theory of the origin of the *F*2 drifts given by Martyn[2]. This theory predicts a phase reversal of east–west component of drifts at a latitude of 35° and a gradual increase of the magnitude of drift from higher to lower latitudes. These conclusions have been qualitatively confirmed by Purslow[3], from the analysis of a limited number of observations taken at Singapore (1° 19′ N., 103° 49′ E. and magnetic lat. 10° S.) over a period of 3 years. In this communication we present the results of our analysis of *F*2-region drift studies made at Waltair (17° 43′ N., 83° 18′ E., magnetic lat. 9° 30′ N.).

Systematic measurement of ionospheric drifts in the *F*2 region were made at Waltair, over the period February 1956–January 1958. The spaced-receiver method of Mitra[4] was used in this investigation, with slight modifications in the method of recording[5]. Drift measurements were made on a frequency of about 6·0 Mc./s. during the day, and on a suitable lower frequency during the night, so as to keep the virtual height of reflexion between the limits 280 km. and 320 km. Care was taken to ensure that the *F*2-region operating frequency was always higher than the critical frequency of the *F*1-region during the day, and of the sporadic *E*-region. Observations were taken at hourly intervals for two to four quiet days each month. During the International Geophysical Year period observations were taken for at least three consecutive days, which included some of the World

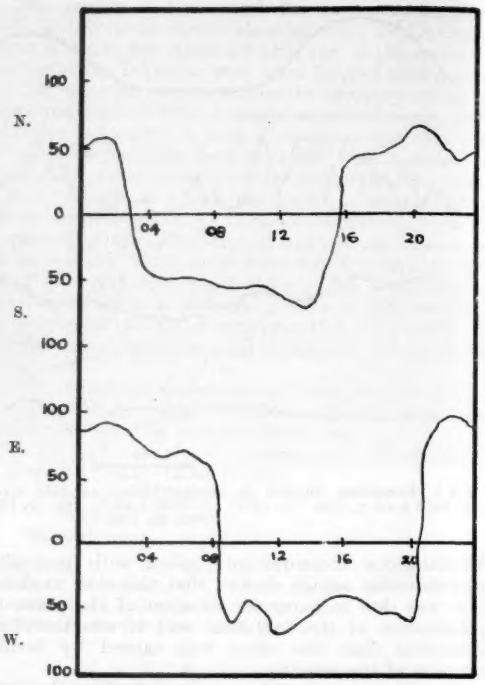

Fig. 1. Diurnal variation of *F*2-region drift components for spring 1957

Days. During this period about 1,500 diurnal records were taken, and of these about 1,000 records showed fading patterns suitable for drift measurement. Following the method of Briggs and Spencer[1], the north–south and east–west components of the observations taken during each season were plotted. The mean curves were drawn by eye and subjected to harmonic analysis to obtain the 24-hr. and 12-hr. components. The diurnal variation curves of the north–south and east–west components for spring 1957 are shown in Fig. 1, to illustrate the general trend of drift variation for that particular season. As the results of harmonic analysis of data obtained during the two years are more or less similar, the results of only one year, including the International Geophysical Year period, are shown in Table 1.

The diurnal variation curves in Fig. 1, as well as the results of harmonic analysis, show clearly a predominant 24-hr. period of drifts in both components. The steady component, as well as the 12-hr. component, is found to be small for all seasons except winter. It may be seen from Table 1 that the 24-hr. east–west component, which lies in the range 80–90 m./sec., is invariably higher than the 24-hr. north–south component, which lies in the range 65–75 m./sec. The phase angle of the north–south component is

Table 1. Results of Harmonic Analysis of *F*2-Region Drifts for the Year 1957
(t = local solar hour angle)

Spring	v (N.–S.)	$= -4{\cdot}4 + 68{\cdot}2 \sin(t+129°) + 5{\cdot}3 \sin(2t+216°)$
	v (E.–W.)	$= +12{\cdot}1 + 85{\cdot}9 \sin(t+58°) + 16{\cdot}0 \sin(2t+18°)$
Summer	v (N.–S.)	$= -0{\cdot}08 + 76{\cdot}0 \sin(t+134°) + 14{\cdot}4 \sin(2t+187°)$
	v (E.–W.)	$= +3{\cdot}0 + 86{\cdot}5 \sin(t+59°) + 4{\cdot}8 \sin(2t+138°)$
Autumn	v (N.–S.)	$= -3{\cdot}5 + 69{\cdot}2 \sin(t+132°) + 12{\cdot}8 \sin(2t+187°)$
	v (E.–W.)	$= +1{\cdot}7 + 88{\cdot}2 \sin(t+59°) + 3{\cdot}0 \sin(2t+210°)$
Winter	v (N.–S.)	$= -13{\cdot}3 + 68{\cdot}0 \sin(t+148°) + 18{\cdot}9 \sin(2t+158°)$
	v (E.–W.)	$= +17{\cdot}4 + 93{\cdot}8 \sin(t+76°) + 35{\cdot}7 \sin(2t+220°)$

invariably found to be higher than the east–west component, indicating a drift direction which is continuously changing in a clockwise sense. The phase difference between the components lies in the range 70–80° and does not show any significant variation from season to season. The amplitudes of the 24-hr. north–south and east–west components being different, and the phase difference being other than 90°, it will be easily seen that the drift vector traces an ellipse in 24 hr., passing through two maxima and two minima.

The drift movements at this latitude are in exactly the opposite direction to those observed at higher latitudes, thus confirming the prediction of Martyn[2] that there should be a phase reversal of *F*2 drifts at a latitude of 35°. It is interesting to note that the amplitude of the 24-hr. east–west component is much higher than the corresponding values obtained for higher latitudes. Using separate expressions for the eastward drift velocity around the magnetic equator, and at high latitudes, Martyn[2] has shown that the maximum eastward drift by day at Cambridge (52° 13′ N. 00° 6′ E. and magnetic lat. 54° 44′ N.) should be 34 m./sec. and the maximum westward drift by day near the magnetic equator should reach a value of 200 m./sec. The maximum westward drift of 80 m./sec. observed at this latitude during daytime falls between these two values, confirming partially the predictions of Martyn, concerning the variation of the maximum east–west component of drift with latitude.

A detailed account of the results of this investigation will be published elsewhere. We are indebted to the Council of Scientific and Industrial Research of India for financial support for these investigations.

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Argon-39 in the Sikhote-Alin Meteorite Fall

The radioactive isotope argon-39 (260-year half-life) has been determined in a specimen of the Sikhote-Alin meteorite fall which occurred on February 12, 1947. This fall[1] was very large, consisting of more than a hundred fragments weighing up to 300 kgm. The measurements were made on samples taken from a 150-gm. bar of the meteorite obtained from Truman P. Kohman, who in turn received the bar from E. L. Krinov. The bar was piece No. 5, which was sawn from specimen No. 2052, according to E. L. Krinov's designation. Argon-39 was not detected in the Carbo meteorite which was found in Mexico in 1923. The detection and measurement of argon-39 in the Sikhote-Alin meteorite makes it possible to determine a new type of age (argon-38/argon-39), which can be called an argon exposure age. The amount of argon-39 also gives an estimate of the cosmic-ray intensity that irradiated the Sikhote-Alin sample in space. From the lack of argon-39 in the Carbo meteorite, the date of fall of which is unknown, one can conclude that it fell more than 1,500 years ago.

The meteorite samples were melted in the presence of 0·21 c.c. of tank argon carrier and all gases were taken from the meteorite. The hydrogen was separated by its passage through a hot palladium thimble. The remaining gas was passed over hot zirconium in order to remove all but the noble gas constituents. After this treatment the gas was absorbed on charcoal at liquid-nitrogen temperature. The argon was removed from the charcoal at 'dry ice' temperature, purified once more over hot zirconium, and put into a small Geiger counter[2] (0·74 c.c. volume) to which butene was added. The Geiger counter was sealed off the line and counted in a low-level system[3]. No carrier argon was lost. The activity was counted for two weeks to be certain that it did not change with time. One of the active counter fillings was transferred back to the system, where the argon purification procedure was repeated. This argon was then recounted. The procedure is similar to that developed by Davis[3]. Table 1 gives the results in the order in which the measurements were made.

Table 1. Argon Measurements

Sample	Weight (gm.)	Counts/day
Tank argon	—	61 ± 3
Carbo	28·6	61 ± 3
Sikhote-Alin	50·5	313 ± 7
Tank argon	—	51 ± 3
Sikhote-Alin*	50·5	270 ± 10
Sikhote-Alin	19·6	170 ± 5

* Repurified sample: 10 per cent of the argon was lost in transferring the counter filling back to the purification system.

Since the radioactivity of the argon did not diminish during a month, was proportional to the weight of the sample, and was not reduced by additional purification of the argon, we conclude that the isotope is argon-39. The sensitive volume of the counter is 95 per cent. The number of argon-39 decays per gm. per day is 5·0 ± 0·2. After equilibrium, the decay rate of argon-39 equals the rate of production of argon-39 by cosmic rays in extra-terrestrial space. No correction is necessary for the time since the fall of the Sikhote-Alin meteorite. The helium-3 in a portion of the same bar was measured as $1·0 \times 10^{-1}$ c.c. per gm.; the argon-38 content of iron meteorites is about 5 per cent of their helium-3 content[3–5]. Schaeffer[4] is measuring the argon-38 and the other noble gas isotopes in another sample of the bar. If cosmic rays produced argon-39 and argon-38 at the same rate, the number of argon-38 atoms divided by the rate of argon-39 decay would give the duration of exposure to cosmic rays.

$$\frac{\text{(No. of } {}^{38}\text{A atoms/gm.)}}{\text{(No. of } {}^{39}\text{A decays/gm. day)}} = \frac{(1·35 \times 10^{12} \text{ atoms/gm.})}{(5·0 \text{ decays/gm. day})} = 7·4 \times 10^{8} \text{ years}$$

However, experimental evidence indicates that argon-38 is produced at a slightly higher rate than argon-39. The argon-38 production cross-section[4] for 430 MeV. protons on iron has been found to be twice that of argon-39. Since the difference would tend to disappear at higher energies, a better estimate

of the relative production-rates of argon-38 to argon-39 may be 1·5. The use of this value gives an argon-exposure age for the Sikhote-Alin meteorite of 5×10^3 years.

The Carbo sample has less than 0·4 argon-39 decays/gm. day. The helium-3 content of an adjacent Carbo sample was found to be $4{\cdot}0 \times 10^{-6}$ c.c./gm. The argon-39 activity is therefore less than 2 per cent of the amount expected if it were a recent fall. This indicates that the Carbo meteorite fell more than 1,500 years ago.

The helium-3 content of our Sikhote-Alin sample is 1/9 of the highest measured in any iron meteorite. If the helium-3 differences are due to differences in shielding and not due to differences in time of exposure to cosmic rays, or differences in extra-terrestrial cosmic-ray intensities, the maximum amount of argon-39 to be expected in an iron meteorite would be nine times the amount observed in our Sikhote-Alin sample. This maximum value is somewhat higher than might be expected from the argon cross-section measurements[5] and the 1949 cosmic-ray intensity at the Earth's poles, but is about what would be expected from the 1954 cosmic-ray intensity.

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Systematic Absences and the X-Ray Diagram of Cellulose

On many X-ray diffraction photographs from high polymers only even-order meridional reflexions are observed. It is therefore assumed that there is a two-fold screw axis in the structure. In general this is valid, but there are special circumstances when such absences occur for a different reason. Thus, in a unit cell containing an asymmetric unit composed of two sub-units, the condition for the observed absences can be satisfied within the asymmetric unit itself if the sub-units have identical distributions of diffracting power along the y-axis (the fibre axis) and are separated by half a cell dimension in the y-direction. The structure can then be regarded as built up of two interlinked lattices, the absent reflexions being associated with the identity of the two lattice units along the y-axis. With polymers where the asymmetric units consist of parts of more than one chain, this condition can be attained by displacing half the chains by half a cell dimension relative to the rest, in the direction of the chain axis, at the same time allowing them to rotate through arbitrary angles about their chain axes. When this rotation is zero, conditions arise similar to those in a centred cell; when it is π the conditions for a two-fold screw axis occur. However, for all degrees of rotation the y co-ordinates remain the same, and the same systematic absences will occur on the meridian.

The effect of this is far-reaching, especially for cellulose, because there is now no *a priori* reason to

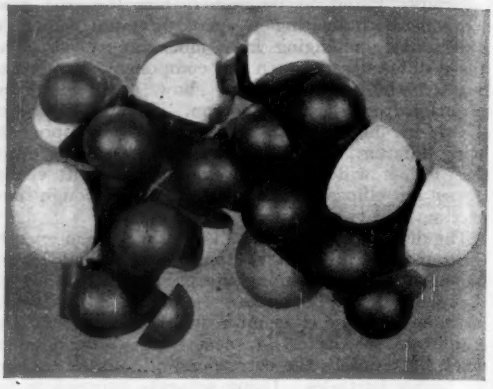

Fig. 1

assume a two-fold screw axis in the structure or in the chain. The removal of this limitation with regard to the cellulose chain makes it possible to postulate other chain configurations for cellulose which hitherto have been neglected because a two-fold screw axis was assumed. One such configuration is that shown in the photograph (Fig. 1), formed from the Meyer–Misch type of chain[1], with standard bond-lengths and angles, by a rotation of one glucose unit relative to the next, which allows easy intra-molecular hydrogen-bonding between O6 and O2′, but no bonding between O3 and the next ring oxygen. It is plausible that this configuration is that found in native celluloses and some other configuration in regenerated celluloses: further work on this subject is in progress.

If this type of chain without a two-fold screw axis is assumed for the structure it is necessary at least to double the unit-cell volume to comply with other structural features. One simple solution is to use the cell formed by the diagonals of the Meyer–Misch unit cell[1], that is, virtually the Sponsler–Dore cell[2,3]. However, recent work by Honjo and Watanabe[4] suggests that an even larger cell is necessary, that is, that obtained by doubling the a- and c- dimensions of the Meyer–Misch cell. Although the use of such a cell accounts for the anomalous reflexions found by these authors, its use also involves explaining the absence of many other reflexions. A general solution, however, can be given if the mechanism discussed

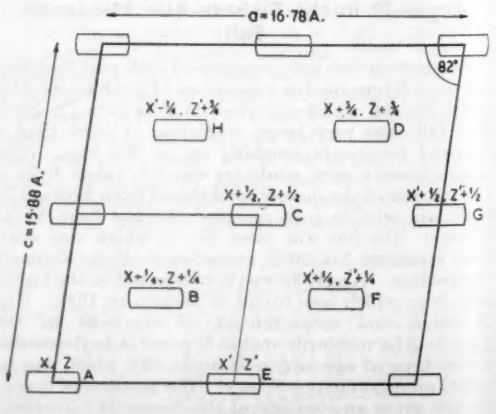

Fig. 2

above is extended to explain systematic absences other than those found on the meridian.

Thus if a space group $P1$ is assumed, as suggested by Honjo and Watanabe, parts of eight different chains will have to be included in the asymmetric unit. The condition that $0k0$ reflexions are absent for k odd can then be achieved by having the y co-ordinates of the eight chains as,

$$y,\ y+p,\ y+q,\ y+r,\ y+\tfrac{1}{2},\ y+p+\tfrac{1}{2},\ y+q+\tfrac{1}{2},\ y+r+\tfrac{1}{2},$$

where p, q, r are arbitrary shifts necessary to achieve the correct bonding and to give the correct conditions for the relative intensities of the even $0k0$ reflexions. It is clear that this does not require all the chains to be parallel; some can be anti-parallel provided that for each chain there is a similar one half a cell-dimension away in the y-direction. The conditions for the x and z co-ordinates are illustrated in the diagram of the $h0l$ projection (Fig. 2). Chains *A*, *B*, *C*, *D* must be similarly oriented and so must *E*, *F*, *G*, *H*, but the two groups can have different orientations. This is, of course, only one of several possibilities. As shown, the anomalous reflexions found by Honjo and Watanabe would be forbidden, but slight deviations of either chains or groups in the chains from this ideal position could allow these reflexions to appear. To proceed from here to a detailed structure of cellulose requires very extensive work, but this communication is intended to show the lines along which such work is needed. Finally, it should be pointed out that the Meyer–Misch structure is an approximation to this proposed structure and should still be useful as a working hypothesis so long as its limitations are realized.

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Magnetic Deflexion of Arcs

Experiments carried out in this Laboratory have suggested that the movement of an arc between metal electrodes in a transverse magnetic field is determined by the motion of the cathode root.

Two principal modes of cathode movement have been noted: (1) when the cathode surface shows continuous tracks—regular movement; (2) when the cathode root moves by jumps, leaving small burn marks scattered at irregular intervals—random movement[1].

Further experiments have been made in air at atmospheric pressure which not only confirm the findings of some earlier experiments[2] in showing the dependence of arc velocity on the conditions in the cathode surface for motion in mode (1), but which have yielded the surprising result that motion in mode (2) is also affected by the cathode material. Furthermore, the velocity in both modes has been shown to be independent of arc current—a result which is contrary to the findings of previous investigators[3–5].

Two cylindrical electrodes, 1 cm. in diameter, were mounted horizontally and parallel in the same vertical plane, 3·2 mm. apart, with the anode uppermost. The electrodes, 15 cm. long, were located centrally in a solenoid, with the field sense such that the arc was driven in the forward direction away from the point 2 cm. from one end, where it was initiated by a fuse wire. Equal currents were fed into the anode from the two ends, and equal currents were taken from each end of the cathode, so that at the cathode root there was no magnetic field produced by the current flowing in the electrodes. The arc was photographed with a rotating drum camera, operating at 960 frames per sec.

It has been found that for fields up to about 500 gauss (above which mode 2 becomes operative) the regular arc velocity on brass was higher than that on mild steel, when both materials were in a clean untreated condition. Although at first sight this result appears to be opposite to that when the arc moves in the magnetic field due to current flowing in the electrodes[1] it is, in fact, consistent with the observation that regular arc velocity is dependent on the magnetic field within the cathode surface[2]. This follows from the fact that the transverse magnetic flux density at the part of the cathode surface where the arc root travels is less in the case of a ferromagnetic material than the flux density in the undisturbed external magnetic field. For both brass and steel it was found that for untreated electrodes there was not a unique regular cathode velocity for a given magnetic field, but that the velocity varied over a range which for mild steel was a little more than $\pm$ 50 per cent of its mean value.

The upper limit of regular velocity for steel (mode 1) was very well defined, and found to be both proportional to flux density and independent of current over the whole range tested, namely, 40–700 amp. and 50–500 gauss.

The scatter in regular cathode velocity for a given flux density appears to be due to surface layers, since when brass was cleaned with a proprietary polishing fluid the scatter was eliminated and the results were highly reproducible. The regular velocity was about one hundred times greater than on highly tarnished brass. The cleaning of steel in this manner gave rise, on the other hand, to very low arc velocities, as the root was found to 'stick'. The velocities on the polished brass were proportional to the magnetic field and independent of current.

For random movement (mode 2) the velocity of the cathode root has been found for mild steel, brass, aluminium and carbon at currents up to 700 amp. and flux densities up to 1,000 gauss to be independent of the current, and to satisfy the relation $V = KB^n$, where B is the transverse flux density and the constants K and n vary with the cathode material.

Since the electrode material has some effect on the velocity of random movement, the deflexion of the arc column cannot be the sole process determining the arc velocity as this would be independent of the electrode material, being merely a transfer of the point of maximum ion and electron densities. Hence it is necessary to postulate an additional process occurring at, or near, the cathode surface, which controls the establishment of emission sites, and

which, therefore, influences the arc velocity in mode 2.

It is suggested that the rise in cathode velocity with increase in arc current found by other investigators[3–5] was due mainly to the fact that in their experiments the current flowing in the electrodes produced an additional field.

Since our experiments indicate that in both modes 1 and 2 the velocity with which the cathode root, and thus the arc, moves is independent of the arc current, but greatly influenced by the condition and material of the cathode surface, it is felt that the conventional concept of an arc between metal electrodes, being deflected in the same way as a flexible physical conductor acted upon by a transverse magnetic field, is open to very grave doubt.

It is hoped to publish elsewhere a more detailed account of this investigation.

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The Reflectance Spectrum of Acetone-2,4-dinitrophenylhydrazone

The advantages afforded by the use of spectral reflectance for *in situ* studies of biochemical systems have been pointed out recently[1]. Characterizing reflectance spectra of the hæm pigments in tuna meat were obtained which were identical with the absorption curves found from transmission measurements made on the same pigments in solution. Although the extension of this technique for the purpose of obtaining useful spectra of organic compounds directly on filter paper would appear both logical and desirable, published studies on this aspect of spectral reflectance are meagre[2,3]. The studies, primarily concerned with the visible region, apparently have overlooked the equally important ultra-violet portion of the spectrum.

We have been able to obtain reproducibly the ultra-violet spectrum of acetone-2,4-dinitrophenylhydrazone on several varieties of filter paper under varying conditions. This hydrazone, a member of a well-known series of compounds, was selected as a model for study since it exhibits in solution three well-defined maxima in the ultra-violet permitting the detection of spectral displacements going from transmission to reflectance. In addition, employment of this hydrazone, which is derived from a symmetrical ketone and which exists in one crystalline form[4], eliminates such potentially complicating and as yet unassessed factors as *cis–trans* isomerism and polymorphism.

The instrument used was a model *DU* Beckman spectrophotometer equipped with photomultiplier and standard reflectance attachment. Samples of Whatman Nos. 1, 3*MM* and 4 filter paper were dipped into solutions of varying concentrations of the purified hydrazone in chloroform for rapid drying and nitrobenzene for slow drying. The samples were allowed to dry spontaneously so that the effect on the spectrum of type of filter paper and rate of drying could be studied. The dry paper sample was placed on a porcelain plate and secured by tape to the stage of the reflectance attachment. The reflectance spectrum of the hydrazone was measured from 220–540 mμ against a reference blank of filter paper cut from the same sheet as the dipped sample. Absorbance was plotted against wave-length in order to permit direct comparison of the reflectance spectrum with the transmission spectrum of the hydrazone, which was measured in absolute ethanol. Typical reflectance and transmission spectra which are shown in Fig. 1 demonstrate clearly that the optical absorption peaks found in transmission are present in reflectance although there is a slight but definite bathochromic displacement for each of the three peaks. The rate of drying of the dipped samples, varying from one to two minutes for chloroform to several days for nitrobenzene and the type of filter paper, seemed to have had little or no effect on the spectrum.

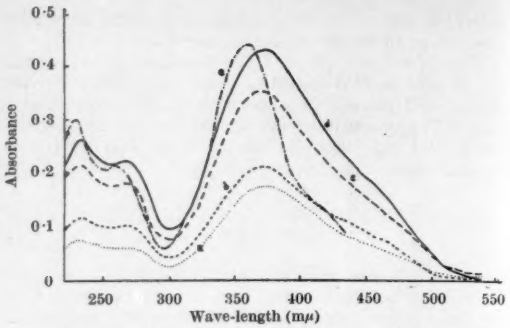

Fig. 1. Comparison of transmission spectrum of acetone-2,4-dinitrophenylhydrazone, in absolute ethanol with reflectance on filter paper. Slow drying, nitrobenzene: *a*, Whatman 3*MM*; *b*, Whatman No. 4. Rapid drying, chloroform: *c*, Whatman No. 1; *d*, Whatman No. 4. Curve *e*, transmission in absolute ethanol

Flood and Bradfield[5] have reported the measurement of the ultra-violet absorption spectra of some plant phenols on paper after insertion of the spotted paper and reference blank in adjacent compartments of the cell carrier of the spectrophotometer. The curves obtained were, in general, similar to those found for the same compounds in solution.

The findings of these workers raised the interesting point regarding the mutual relation between the reflectance and transmission spectrum on paper. The question was easily resolved by the measurement of the reflectance spectrum of the hydrazone on paper with the reflectance attachment followed by transmission measurement of the same sample according to the method of Flood and Bradfield. The results show (Table 1, Figs. 2, 3) that the maxima of the

Table 1. Spectrum of Acetone-2,4-dinitrophenylhydrazone

Spectrum	$\lambda_{max.}$ (mμ)		
Transmission in absolute ethanol	228	260	360
Transmission on Whatman No. 1 (chloroform)	233	268	368
Reflectance ,, ,, ,, 1 ,,	232	268	370
Transmission ,, ,, ,, 4 (chloroform)	233	268	368
Reflectance ,, ,, ,, 4 ,,	232	268	370
Transmission ,, ,, ,, 1 (nitrobenzene)	233	270	370
Reflectance ,, ,, ,, 1 ,,	233	268	370
Transmission ,, ,, ,, 4 ,,	233	268	368
Reflectance ,, ,, ,, 4 ,,	233	268	370

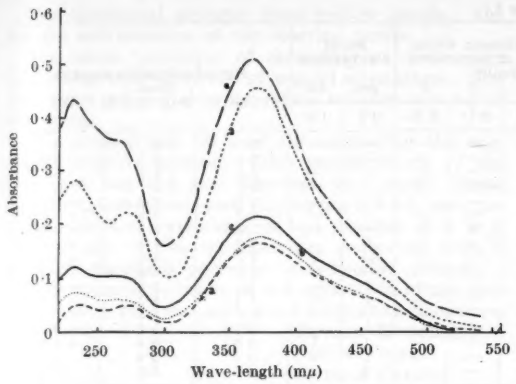

Fig. 2. Acetone-2,4-dinitrophenylhydrazone: comparison of reflectance with transmission spectrum on different types of filter paper. Slow drying in nitrobenzene. Reflectance: *a*, Whatman No. 1; *b*, Whatman 3*MM*; *c*, Whatman No. 4. Transmission: *d*, Whatman No. 1; *e*, Whatman No. 4

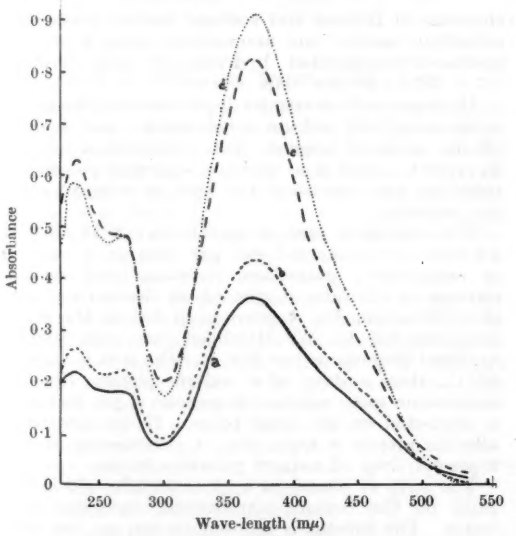

Fig. 3. Acetone-2,4-dinitrophenylhydrazone: comparison of reflectance with transmission spectrum on different types of filter paper. Rapid drying in chloroform. Reflectance: *a*, Whatman No. 1; *b*, Whatman No. 4. Transmission: *c*, Whatman No. 1; *d*, Whatman No. 4

reflectance and the transmission spectra are identical although the $E_{max.}$ of the latter are higher. In one instance, it was possible to obtain the reflectance but not the complete transmission spectrum on No. 3 *MM* paper, a failure attributed to the opacity of this relatively thick paper to transmitted light below 240 mμ.

We are of the opinion that the results obtained so far, together with those in progress, indicate that characteristic spectra of organic compounds may be obtained on a routine basis directly on filter paper. The need for extraction, which in certain circumstances may be difficult or impossible, is thus eliminated. In light of the rapid advances that have been made in the field of paper chromatography this application of spectral reflectance merits the serious consideration of interested workers.

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Hyperconjugation due to Hydrogen Atoms in β, γ and δ Positions

THE recent statement by Kreevoy and Eyring[1], based on theoretical considerations, that the hyperconjugation energy is approximately proportional to the number of α-hydrogen atoms, is supported by an empirical relation discovered independently during the course of other work. This shows that not only α-hydrogen atoms but also hydrogen atoms attached to β, γ and δ carbon atoms influence the hyperconjugation energy of olefines.

On studying the hyperconjugation energies of olefines determined from the heats of hydrogenation[2], it was observed that tertiary butyl ethylene (2 : 2-dimethylbutene-$\Delta^{3:4}$) has a hyperconjugation energy almost identical with propylene. Now tertiary butyl ethylene has no α-hydrogen atoms with respect to the double bond, and it was therefore clear that the nine β-hydrogen atoms are approximately equal in their effect to the three α-hydrogen atoms of propylene. After solving a series of linear equations, it was found that the hyperconjugation energy of olefines containing one alkyl group attached to the double bond can be expressed by the empirical relation:

$$H = a.H_\alpha + b.H_\beta + c.H_\gamma + d.H_\delta$$

where *a*, *b*, *c* and *d* are the number of hydrogen atoms in the α, β, γ and δ positions with respect to the double bond. H_α (0·8), H_β (0·3), H_γ (0·18) and H_δ (0·07) are the contributions to the hyperconjugation energy of the olefine in kilocalories, for each hydrogen atom in the α, β, γ and δ positions respectively. The values in brackets are the best values of the increments for each hydrogen atom in that position, and they decrease exponentially as the distance from the double bond increases.

If more than one alkyl group is attached to the double bond, then these reduce the stability of the molecule due to steric strain so that the above empirical relation is no longer so accurate. It is therefore necessary to amend the above relationship to:

$$H = a.H_\alpha + b.H_\beta + c.H_\gamma + d.H_\delta - x.G - y.C$$

where x is the number of carbon atoms of the double bond with two alkyl groups attached, and y is the number of alkyl groups in the *cis* position with respect to the double bond. G (0·5) represents the decrease in stability of the olefine for two alkyl groups attached to the same carbon atom, and C (1·0) is the decrease in stability due to two alkyl groups in the *cis* position. The numbers in brackets are the best values of these parameters in kilocalories.

Table 1

Name	Formula	No. of hydrogen atoms and value of parameters (kcal.)				No. of alkyl groups		Hyperconjugation energies (kcal.)		
		α	β	γ	δ	*gem*	*bis*	Calc.	Exp. (ref. 2)	Diff.
		0·8	0·3	0·18	0·07	0·5	1·0			
Ethylene	$CH_2 : CH_2$	—	—	—	—	—	—	0	0	0
Propylene	$CH_3CH : CH_2$	3	—	—	—	—	—	2·4	2·7	− 0·3
Butene-1	$CH_3CH_2CH : CH_2$	2	3	—	—	—	—	2·5	2·5	0
Heptene-1	$CH_3(CH_2)_4CH : CH_2$	2	2	2	2	—	—	2·7	2·7	0
*iso*Propyl-ethylene	$(CH_3)_2CHCH : CH_2$	1	6	—	—	—	—	2·6	2·5	+ 0·1
t-Butyl-ethylene	$(CH_3)_3CCH : CH_2$	—	9	—	—	—	—	2·7	2·5	+ 0·2
*neo*Pentyl-ethylene	$(CH_3)_3CCH_2CH : CH_2$	2	—	9	—	—	—	3·22	3·3	− 0·08
*iso*Butene	$(CH_3)_2C : CH_2$	6	—	—	—	1	—	4·3	4·4	− 0·1
cis-Butene-2	$CH_3CH : CHCH_3$	6	—	—	—	—	1	3·8	4·2	− 0·4
trans-Butene-2	$CH_3CH : CHCH_3$	6	—	—	—	—	—	4·8	5·2	− 0·4
as-Methyl-*iso*propyl-ethylene	$(CH_3)_2CHC(CH_3) : CH_2$	4	6	—	—	1	—	4·5	4·8	− 0·3
as-Methyl-ethyl-ethylene	$CH_3CH_2C(CH_3) : CH_2$	5	3	—	—	1	—	4·4	4·3	+ 0·1
Pentene-2*	$CH_3CH_2CH : CHCH_3$	5	3	—	—	—	—	4·9	4·8	+ 0·1
2 : 4 : 4-Trimethyl-pentene-1	$(CH_3)_3CCH_2C(CH_3) : CH_2$	5	—	9	—	1	—	5·12	5·1	+ 0·02
2 : 4 : 4-Trimethyl-pentene-2	$(CH_3)_3CCH : C(CH_3)_2$	6	9	—	—	1	1	6·0	4·4	+ 1·6
Trimethyl-ethylene	$(CH_3)_2C : CHCH_3$	9	—	—	—	1	1	5·7	5·9	− 0·2
Tetramethyl-ethylene	$(CH_3)_2C : C(CH_3)_2$	12	—	—	—	2	2	6·6	6·2	+ 0·4
cyclo-Hexene		4	4	4	4		1	4·4	4·2	+ 0·2
cyclo-Pentene		4	4	4				5·12	5·9	− 0·78
cyclo-Heptene		4	4	4	4			5·40	6·3	− 0·70
cyclo-Octene		4	4	4	4			5·40	9·3	− 3·9

* Mixture of *cis* and *trans* isomers.

Using this last relationship it is possible to calculate the hyperconjugation energies of aliphatic monoolefines with an accuracy of about 0·5 kcal. Monosubstituted olefines have the best agreement, and 2 : 4 : 4-trimethylpentene-$\Delta^{2:3}$ has the least accurate agreement with the empirical rules, due no doubt to the high steric hindrance of the tertiary butyl group. Cyclohexene shows good agreement with the empirical rules, but other cyclic olefines show large discrepancies, presumably due to strain in the ring (Table 1).

From this evidence it may be seen how difficult it is to isolate hyperconjugation from other effects. It appears that the ratio of the increments for the hydrogen atoms in different positions corresponds to the ratios of the overlap integrals in the secular equations, which are usually assumed to be zero for non-adjacent atoms. Calculations based on these empirical relationships are at present in progress and will be published in detail in due course.

I am indebted to Prof. M. Ashworth and Dr. F. Becker for several stimulating discussions.

S. G. Beech

Chemisches Institut,
Universität des Saarlandes,
Saarbrücken 15. April 15.

[1] Kreevoy, M. M., and Eyring, H., *J. Amer. Chem. Soc.*, **79**, 5121 (1957).
[2] Conant, J. B., and Kistiakowsky, G. B., *Chem. Rev.*, **20**, 181 (1937)

Paper Chromatography of Potassium, Rubidium and Cæsium

Although the separation of lithium, sodium and potassium by paper chromatography is not difficult, only three mixtures of solvents seem to have been proposed to accomplish the chromatographic separation of potassium, rubidium and cæsium. A. E. Steel[1] recommended the use of a saturated solution of phenol in hydrochloric acid; but the chromatograms run under these conditions do not give reproducible R_F-values. Separation has also been obtained by the method of C. C. Miller and R. J. Magee[2], with a solvent consisting of concentrated hydrochloric acid/methanol/*n*-butanol/*iso*butylmethyl ketone (55 : 35 : 5 : 5 v/v). Recently, R. J. Magee and J. B. Headridge[3] claimed better results for the chlorides of lithium and sodium, and of potassium, rubidium, cæsium and ammonium, using a phenol/methanol/concentrated hydrochloric acid mixture (57·5 : 22·5 : 20 per cent w/v/v).

All these methods require development of the spots, by spraying with sodium cobaltinitrite, and washing off the excess of reagent. This procedure is tedious. In order to avoid this, we have separated potassium, rubidium and cæsium in the form of coloured salts, the picrates.

The technique used is as follows: 2–10 μl. of a solution containing 0·1–0·5 per cent of a mixture of ammonium, potassium, rubidium and cæsium nitrates or chlorides is spotted on the narrow part of a Whatman No. 4 paper-strip cut in the shape recommended by W. Matthias[4] but with slightly modified dimensions (see Fig. 1). The spot is dried at 60° C., then a drop of a sodium picrate (free of ammonium salts) solution in acetone (1 per cent w/v) is deposited on the same place. If the content of alkaline metals is high, then it is necessary to add a second drop of sodium picrate solution.

The strip is placed in a glass trough, which contains on the bottom nitrobenzene saturated with water. The solvent is allowed to run up the filter paper until the front reaches a height of more than 1·5 cm. to ensure the spacing of the bands. Then the chromatogram is removed from the trough and dried at 60° C.

Fig. 1

The developed picrates form yellow bands; the sodium salt remains at the starting point.

The usual technique of ascending or descending chromatography does not give good separations. The R_F values are too close to obtain suitable spacing of the spots.

Our method can be used for estimating the separated ions as picrates. The yellow bands of the strip are cut out and inserted into small glass-stoppered test-tubes, each containing 2·0 ml. acetone. After complete extraction of the picrates (2–3 hr.), the colours of the solutions are compared with a scale of standards prepared in a similar manner.

Experiments to improve the separation of the picrates are in progress and will be reported elsewhere.

FLORIN MODREANU
SIMON FISEL
ADRIAN CARPOV

Chemical Institute,
Roumanian Academy of Sciences,
Jassy, Roumania.

[1] Steel, A. E., *Nature*, **173**, 315 (1954).
[2] Miller, C. C., and Magee, R. J., *J. Chem. Soc.*, 3183 (1951).
[3] Magee, R. J., and Headridge, J. B., *Analyst*, **82**, 95 (1957).
[4] Matthias, W., *Der Züchter*, **24**, 313 (1954).

Loss of Moisture from Vegetation

THE successful application of the formulæ of Penman[1] and others to the estimation of the water requirements of crops has directed attention to the influence of weather on natural evaporation. Measurements made during the last two years at Palmerston North, New Zealand, have indicated that the form of the vegetation can significantly influence the rate of loss of moisture from the soil.

Gypsum blocks have been used[2] to measure the moisture content of the soil under adjacent long and short pastures which completely covered the soil and were of similar colour. The experimental plots were about one-twentieth of an acre in area with no dividing paths or fences. Fig. 1 shows the moisture contents under two lengths of pasture growing on a silt loam in a sheltered area during the late summer and autumn of 1957. Measurements made the previous summer show a similar result. Moisture was lost at a greater rate and from greater depths from the soil under the short pasture. The experimental areas were unirrigated and the moisture content of the soil was below the field capacity from the end of the first week in January until the measurements were stopped at the end of March. Under these conditions drainage would be negligible and it can be assumed that the moisture content of the soil was determined by the rainfall and the evaporation.

In the spring of 1957 there was a period of relatively dry weather when 0·95 in. of rain fell in four weeks. During this period, at a site exposed to the wind, the water stored in the top 8 in. of soil under a short pasture was depleted from 2·3 in. to 1·55 in. During the same period, the amount of water stored under an adjacent long pasture decreased from 2·3 in. to 0·78 in.

In this case more water was lost from the long pasture than was lost from the short pasture. Rider[3] obtained a similar result from the use of aerodynamic techniques at Cambridge.

It is believed that these conflicting results might be explained by the physical differences between the long and the short pasture. In the short pasture the region of maximum heat transfer and hence of highest temperature on a sunny day is restricted to a narrow zone at and just below the surface of the soil. In the long pasture this zone of maximum temperature is spread over a considerable depth within the vegetation. In this region in the long pasture there is a rapid exchange of heat between the large leaf area and the air. Consequently the temperature of the leaves is never very different from that of the air. In the short pasture the leaf area is much smaller and the heat exchange between the plants and the air is less than in the long pasture. In bright sunlight the temperature of the leaves will tend to be higher than the temperature of the air.

Some preliminary measurements have indicated that the temperature of the leaves in the short pasture can be up to 10° C. above the air temperature on a sunny day, while the temperature of the leaves in the long pasture seldom exceeds the temperature of the air by more than 1° C.

Under conditions of low intensity of radiation the temperatures of the leaf surfaces in both the long and the short pasture have been found to be approximately the same. As the area of the leaves exposed to the air is greater in the long pasture than in the short pasture, more water should be lost from the long pasture. The difference between the rates of evaporation from the two pastures will be accentuated by high wind velocities.

Under conditions of high intensity of radiation the temperature of the evaporating surfaces in the short pasture could be sufficiently greater than that of the evaporating surfaces in the long pasture to over-

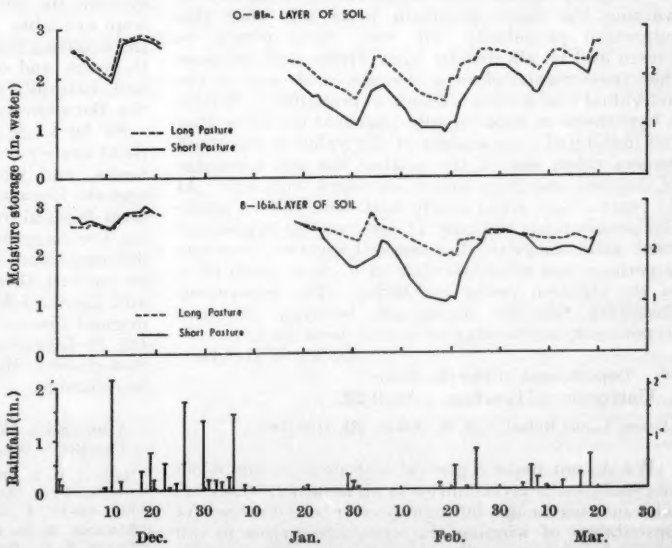

Fig. 1. Moisture content of the soil under long and short pasture during the late summer and autumn of 1957

compensate for the larger evaporating surface in the latter. If this situation arises the evaporation from the short pastures would be greater than that from long pasture. The effect would be accentuated by low wind velocities, reducing the effectiveness of the large area of the leaves in the long pasture.

Other features, such as whether or not the structure of the vegetation tends to trap air, will also be of importance.

Current measurements at a chain of twenty-five microclimate stations at sites from 35° S. to 45° S. and also from recordings of the diurnal flux of temperature under different covers of vegetation should allow a more detailed consideration of these issues.

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Grasslands Division,
Department of Scientific and
Industrial Research,
New Zealand.

R. L. Closs

Dominion Physical Laboratory,
Department of Scientific and
Industrial Research,
New Zealand.

Feb. 18.

[1] Penman, H. L., *Proc. Roy. Soc.*, A, **193**, 120 (1948).
[2] Bouyoucos, G. D., and Mick, A. H., Mich. Agric. Exp. Sta. Tech. Bull. 172 (1940).
[3] Rider, N. E., Meteor. Res. Pub. 972 (1956).

Subjective Probability, Gambling and Intelligence

In a communication under the above title, Cohen and Hansel[1] point out that if a prize is certain and large enough, in relation to the individual's scale of values, it will be preferred to an uncertain prize however much larger, whereas if the certain prize is negligible the uncertain but worthwhile prize will be preferred. They postulate that at intermediate values of the certain prize, the preference for it will be weighed against the subjective probability of winning the large uncertain prize and that this subjective probability will vary from person to person and be affected by age. Hence they suppose that their results show a decrease with age in the individual's subjective estimate of probability. Surely, a hypothesis at least equally plausible would be that the individual's assessment of the value of the small certain prize, and of the smaller but less uncertain of the two uncertain prizes, increases with age. At 15 years of age, when nearly half the children prefer the certain prize and only 14 per cent the largest and most uncertain prize, the imagined appetite for sweets is perhaps less wholesale than at 9 years, when most of the children prefer the latter. The experiment described fails to distinguish between the two hypotheses, which may of course both be true.

O. V. S. Heath

Department of Horticulture,
University of Reading. April 23.

[1] Cohen, J., and Hansel, C. E. M., *Nature*, **181**, 1160 (1958).

We do not make a general statement to the effect that subjective probabilities in all situations diminish with increase in age, but merely refer to the subjective probability of winning the uncertain prizes in our particular experiments. Secondly, we do not speak of subjective estimates of probability but of 'subjective probability'. That is, our subjects do not make any estimates of probabilities. Indeed, these are explicitly stated to them. What they do is make a choice or express a preference; and this choice or preference is perhaps influenced by their subjective assessment of the value of the prize—the point which Prof. Heath emphasizes—as well as by how likely they think they are of getting it. We have no indication that our subjects distinguish between these two components in making their choice. We referred in particular to the second component but do not wish to deny the possible significance of the first. Indeed, we explicitly stated in the last sentence of our communication that the subjective probability on which the preference is based is affected by the *value* of the prizes offered. On the other hand, if the explanation rested only on the supposed reduction with age in the "imagined appetite for sweets", we should also have to conclude that this appetite increases with intelligence.

John Cohen
C. E. M. Hansel

Department of Psychology,
University of Manchester.

The Macleod Equation

There is a widespread impression that Macleod was the first to discover the relation:

$$\gamma = C(D-d)^4$$

where γ is the surface tension, D the density of the liquid, d the density of the saturated vapour and C a constant independent of temperature for non-associated liquids. The equation, which Macleod[1] put forward on empirical grounds in 1923, was referred to as the Macleod relation in a paper published by Sugden[2] in 1924, and this designation has since been consistently adopted in the European and American literature.

It has now come to my notice that the equation had been formulated empirically in 1922 by Batschinsky[3], who examined its applicability to all systems for which surface tension and density data were available. His demonstration of the validity of the equation for non-associated systems was far more thorough and comprehensive than that of Macleod, and, naturally enough, the equation is referred to as the Batschinsky relation in the Russian literature.

So far back as 1911, however, Kleeman[4] had derived the equation from his theory of intermolecular forces, and had shown that it applied to typical organic liquids. Although the equation has since been deduced by combining the power laws representing the temperature variation or orthobaric density difference and surface tension[2], and has been related to modern theories of the liquid state by Fowler[5] and Lennard-Jones and Corner[6], the credit for its original discovery undoubtedly belongs to Kleeman. Its re-designation as the Kleeman or Kleeman–Batschinsky–Macleod equation appears therefore to be desirable.

S. T. Bowden

University College,
Cardiff. April 20.

[1] Macleod, D. B., *Trans. Farad. Soc.*, **19**, 38 (1923).
[2] Sugden, S., *J. Chem. Soc.*, **125**, 32 (1924).
[3] Batschinsky, A., *Izv. fiz. Inst. Biol. Fiz.*, **2**, 60 (1922).
[4] Kleeman, R. D., *Phil. Mag.*, **21**, 99 (1911).
[5] Fowler, R. H., *Proc. Roy. Soc.*, A, **159**, 229 (1937).
[6] Lennard-Jones, J. E., and Corner, J., *Trans. Farad. Soc.*, **36**, 1156 (1940).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, June 9

UNIVERSITY OF LONDON (at the London Hospital Medical College, Turner Street, London, E.1), at 5.30 p.m.—Prof. A. Albert (Australian National University): "Chemical Aspects of Selective Toxicity".*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Sir Vivian Fuchs and Sir Edmund Hillary: "Commonwealth Trans-Antarctic Expedition".

Tuesday, June 10

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Wednesday, June 11

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Thomas Frohock Gaskell: "Drilling Deep Holes into the Earth".

Thursday, June 12

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. Martin Ryle, F.R.S.: "The Nature of the Cosmic Radio Sources" (The Bakerian Lecture).

UNIVERSITY OF LONDON (in the Anatomy Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Marshall Clagett (Wisconsin): "Before Galileo: the Science of Mechanics in the Middle Ages".* (Further lecture on June 16.)

Friday, June 13—Saturday, June 14

BRITISH SOCIETY FOR IMMUNOLOGY (at the National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7), at 1.45 p.m. on Friday—Symposium on "Gamma-globulin and Antibodies". Chairman: Sir Charles Harington, F.R.S.

Saturday, June 14

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.35 p.m.—Prof. J. Z. Young, F.R.S.: "Unit Memory Processes in Octopus".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN GEOLOGY—The Registrar, The University, Manchester 13 (June 11).

PHYSICIST (male or female, with an honours degree) at Watson House, Fulham, London, S.W.6, to carry out research on the aerodynamics of combustion systems involving flow visualization and the development of new measurement techniques—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting Ref. TT/573 (June 12).

ASSISTANT, Grade B (preferably with experience in industry, teaching and/or research), IN INORGANIC CHEMISTRY—The Principal, Nottingham and District Technical College, Shakespeare Street, Nottingham (June 14).

ASSISTANT (preferably with interests in the petrological-mineralogical side) IN THE DEPARTMENT OF GEOLOGY—The Secretary, The University, Edinburgh (June 14).

LECTURER (with special interests in igneous petrology and structural geology) IN GEOLOGY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (June 14).

RESEARCH ASSISTANT (graduate in physiology, pharmacology or biochemistry) IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS, to join in the investigation of the effect of ionizing radiation on thyroid function—The Registrar, The University, Sheffield (June 14).

SENIOR LECTURER (with a good honours degree in mathematics with specialist qualifications in statistics or numerical analysis, and experienced in the use of analogue machines and/or high-speed computers) IN MATHEMATICS; and an ASSISTANT, Grade B, IN THE DEPARTMENT OF PHYSICS, to teach to the standard of the Diploma in Technology in Applied Physics—The Principal, Brunel College of Technology, Woodlands Avenue, Acton, London, W.3 (June 14).

READER (with experience in experimental physics and interested in the teaching of physics to scientists in other fields, particularly chemists and biologists) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (June 16).

GUIDE LECTURER (man or woman, 30 or over, with university degree, or equivalent, in science or engineering, and preferably lecturing experience and a knowledge of French or German) AT THE SCIENCE MUSEUM, South Kensington, London, S.W.7—The Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting S.4845/58/7 (June 17).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with at least an honours degree in chemistry or agriculture) IN THE NUTRITION DEPARTMENT, for energy metabolism studies, principally on sheep—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr Scotland (June 20).

ASSISTANT LECTURER or LECTURER IN PURE MATHEMATICS—The Registrar, University College of Swansea, Singleton Park, Swansea (June 21).

RESEARCH ASSISTANT IN PHYSIOLOGY—The Registrar, The University, Sheffield (June 21).

LECTURER (with special qualifications in high-voltage engineering) IN ELECTRICAL ENGINEERING—The Registrar, The Manchester College of Science and Technology, Manchester 1 (June 23).

LECTURER (graduate with a wide knowledge of microbiology) IN THE DEPARTMENT OF BOTANY AND PLANT TECHNOLOGY—The Professor of Botany, Imperial College, London, S.W.7 (June 23).

ASSISTANT LECTURER or LECTURER (with a special interest in mineralogy and petrology or in geomorphology) IN GEOLOGY at the University College of Ghana—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 30).

RESEARCH ASSISTANT (man or woman graduate) IN BOTANY, to conduct research into an electro-osmotic theory of phloem transport—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (June 30).

RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (June 30).

CHAIR OF EXPERIMENTAL MEDICINE at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 2).

READER IN PHYSICAL OCEANOGRAPHY at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 2).

SENIOR TECHNICIAN IN BIOCHEMISTRY in the new Area Laboratory, Dumfries—The Secretary, Royal Infirmary, Dumfries (July 12).

SENIOR LECTURER IN PHYSICAL CHEMISTRY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, S.W.1 (Hong Kong, July 15).

LECTURER IN ZOOLOGY at the University of Auckland, New Zealand,—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

ASSISTANT LECTURER to teach laboratory arts and workshop practice, with some elementary science in laboratory technicians' courses—The Principal, Cambridgeshire Technical College, Collier Road, Cambridge.

ASSISTANT LECTURER (with a good honours degree, preferably in botany with subsidiary zoology, and some research and demonstrating experience) IN BIOLOGY—The Secretary, Sir John Cass College, Jewry Street, London, E.C.1.

ASSISTANT PROFESSOR (with at least a Ph.D. degree in theoretical physics, and preferably with training in theoretical nuclear physics or other field of theoretical physics suitable for effective association with the experimental physicists working on photonuclear reactions at the 70 MeV. synchrotron in the Department), to undertake teaching and research in the DEPARTMENT OF PHYSICS—Head of the Department of Physics, Queen's University, Kingston, Ontario, Canada.

EDITORIAL ASSISTANT, Assistant Experimental Officer or Experimental Officer grade (with G.C.E. (Advanced) in two scientific subjects, or, if over 22, a pass degree or H.N.C. in a science subject) at the Road Research Laboratory (D.S.I.R.), Harmondsworth, Middlesex, for editing and preparing for publication all articles to technical journals, and official booklets issued by the laboratory—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.81/8A.

HOSPITAL BIOCHEMIST, Basic grade (A.R.I.C., or B.Sc., preferably with honours), IN THE PATHOLOGY DEPARTMENT associated with St. Andrews University Medical School—The Medical Superintendent, Dundee Royal Infirmary, Dundee.

INSTRUCTOR, ASSISTANT PROFESSOR or LECTURER (with the degree of Ph.D. or equivalent research experience, and prepared to direct research in experimental physics) IN PHYSICS—The Chairman, Department of Physics, Western Reserve University, Cleveland 6, Ohio, U.S.A.

LABORATORY TECHNICIAN (able to work with the minimum of supervision, a sound knowledge of chemistry and some experience of biochemical technique) for a biochemical research unit—The Administrator, Department of Biochemistry, The University, South Parks Road, Oxford.

LECTURER IN GEOLOGY—The Secretary, Sir John Cass College, Jewry Street, London, E.C.1.

MASTER TO TEACH PHYSICS to University Scholarship Standard and MATHEMATICS in the Middle School—The Headmaster, The Perse School, Cambridge.

MICRO-ANALYST IN THE ORGANIC CHEMISTRY DIVISION of the National Chemical Research Laboratory, Pretoria, South Africa, to take charge of the microanalytical laboratory attached to the Organic Chemistry Division—The Director, National Chemical Research Laboratory, Council for Scientific and Industrial Research, Private Bag 191, Pretoria, South Africa, and South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2.

PHYSICIST, Basic grade (honours graduate) IN THE REGIONAL PHYSICS DEPARTMENT, Dundee, to participate in a wide range of applications of physics to medicine—The Secretary, Eastern Regional Hospital Board, 430 Blackness Road, Dundee.

PHYSICS MASTER (young graduate)—The Headmaster, St. Albans School, Abbey Gateway, St. Albans, Herts.

RESEARCH ASSISTANT or GRADUATE RESEARCH STUDENT (BIOLOGIST), to take part in a study on the effect of X-irradiation on mammalian germ cells—The Director, Department of Anatomy, The Medical School, The University, Birmingham 15.

RESEARCH ASSISTANTS IN (*a*) PHYSICS, (*b*) TELECOMMUNICATIONS, AND (*c*) CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

RESEARCH ASSOCIATE (Ph.D., M.D., or equivalent) mainly for independent research in the areas of automatic or cardiovascular-renal physiology and pharmacology or pharmacodynamics—Dr. Mark Nickerson, Department of Pharmacology and Therapeutics, University of Manitoba, Winnipeg, Manitoba, Canada.

RESEARCH OFFICER (with an honours degree in biology and an interest in research work, preferably entomological) AT THE EAST AFRICAN INSTITUTE OF MALARIA AND VECTOR-BORNE DISEASES, Amoni, Tanganyika, to teach Europeans and Africans in the control of insect-borne diseases, to provide assessment and advice on control problems, and to undertake field and other research in connexion with arthropod and mollusc behaviour and the application of insecticides—The Director of Recruitment, Colonial Office, London, S.W.1 quoting BCD.195/205/06.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Macaulay Institute for Soil Research. Annual Report, 1956–1957. Pp. 66. (Craigiebuckler, Aberdeen: Macaulay Institute for Soil Research, 1958.) [193

This is the British Glass Industry. Pp. 32. (London: Glass Manufacturers' Federation, 1958.) [193

Royal Institute of Chemistry. Report of the Council for the year ended 30th September, 1957. Pp. 28. (London: Royal Institute of Chemistry, 1957.) [193

Aluminium in Metalwork and in Science. By William H. Edwards. Pp. ii+14. (London: Science Club, 1958.) 5*s*. [193

Government of Northern Ireland: Ministry of Agriculture. Leaflet No. 31: Coccidiosis in Poultry. Pp. 5. Leaflet No. 64: Warble Flies in Cattle. Pp. 4. (Belfast: Ministry of Agriculture, 1958.) [203

Wool Industries Research Association. Report of the Director of Research for 1957–58. (WIRA Publication No. 211.) Pp. 30. (Torridon, Headingley, Leeds: Wool Industries Research Association, 1958.) [213

Bulletin of the British Museum (Natural History). Botany. Vol. 2, No. 4: *Saxifraga* of the Himalaya. 1: Section *Kabschia*. By Harry Smith. Pp. 83–129. 15*s*. Entomology. Vol. 6, No. 10: The Identity of *Stenopsyche griseipennis* McLachlan (Trichoptera, Family Stenopsychidae.) By D. E. Kimmins. Pp. 251–260. 3*s*. 6*d*. (London: British Museum (Natural History), 1958.) [213

Planning, Vol. 24, No. 420 (24 March 1958): Television in Britain. Pp. 37–68. (London: Political and Economic Planning, 1958.) 3*s*. 6*d*. [243

Bulletins of Marine Ecology (formerly Hull Bulletins of Marine Ecology). No. 39, Vol. 5 (December, 1957): An Ecological Survey of the Drift-Net Herring Fishery Off the North-East Coast of Scotland. Part 2: The Planktonic Environment of the Herring. By R. S. Glover. Pp. 43+plates 1–8. (Edinburgh: Scottish Marine Biological Association, 1957.) 13*s*. [243

Natural Science and Social Science. By Sir Alexander Carr-Saunders. (Eleanor Rathbone Memorial Lecture.) Pp. iv+15. (Liverpool: Liverpool University Press, 1958.) 3*s*. [243

Mental Health Research Fund. Annual Report 1957 and Balance Sheet as at 30th September, 1957, with Income and Expenditure Account for the year to that date. Pp. 16. (London: Mental Health Research Fund, 1958.) [243

The National Union of Teachers Annual Guide to Careers for Young People: a Guide for those advising Boys and Girls Leaving School. Second annual edition. Pp. 68. (London: National Union of Teachers, 1958.) 3*s*. [243

Endemic Goitre: World Distribution and Incidence—Select Bibliography. Pp. iii+104. (London: Chilean Iodine Educational Bureau, 1958.) [263

The Royal Air Force, 1918–1958. Pp. 40. (London: Air Ministry, 1958.) [263

Transactions of the Royal Society of Edinburgh. Vol. 63, Part 2 (No. 17): The Small Spore Floras of Coals in the Limestone Coal Group and Upper Limestone Group of the Lower Carboniferous of Scotland. By Dr. Mavis A. Butterworth and Dr. Ralph W. Williams. Pp. 353–392 +4 plates. (Edinburgh: Royal Society of Edinburgh, 1958.) 15*s*. [263

Annual Report of the Ramblers Association, 1957. Pp. 16. (London: The Ramblers Association, 1958). [263

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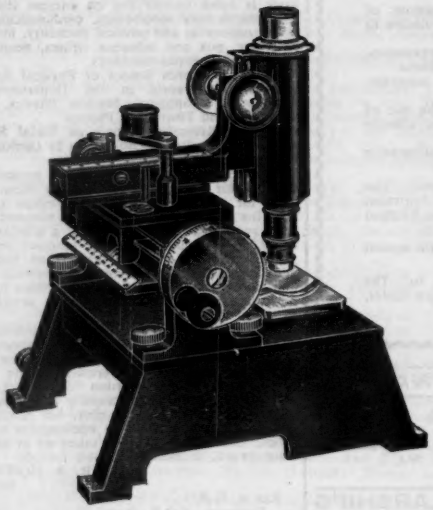

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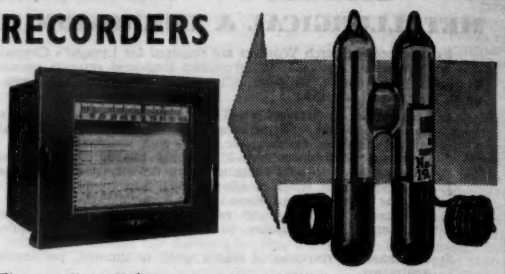

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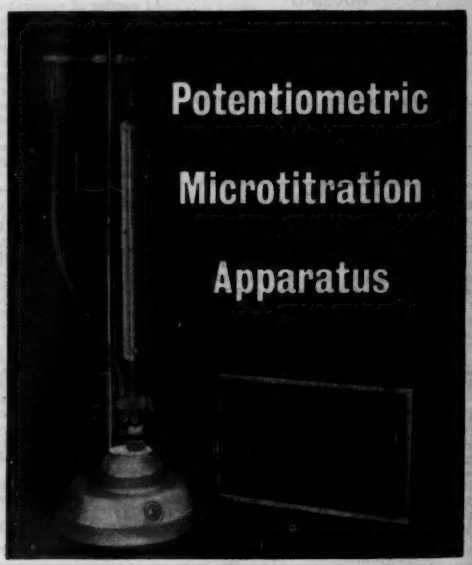

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